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INVENTIONS,

IMPROVEMENTS, AND PRACTICE

OF

BENJAMIN THOMPSON,

IN THE

COMBINED CHARACTER

OF

COLLIERY ENGINEER,

AND

GENERAL MANAGER.

WITH

SOME INTERESTING PARTICULARS RELATIVE TO WATT'S STEAM ENGINE,

AND A SHORT

TREATISE ON THE COAL TRADE REGULATION.

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ADVERTISEMENT.

The following pages have been recently written, partly for amusement, and partly with the view of collecting together, and describing (those given being a portion only of) the inventions and improvements which had engaged the Author, at intervals, in connexion with his occupations, during a course of many years; and not with the remotest intention of publishing them. Having, however, been advised that the work contained matter that would probably be acceptable to persons in the coal trade, he was, at length, persuaded to send it to the press.

Fully aware that this small volume cannot offer anything, in the smallest degree, attractive to the general reader, the Writer is yet not without a hope that, to the coal trade *public* of these northern counties, it may furnish information both of interest and utility; but, more especially, to colliery engineers (or engine wrights, as they are commonly designated)—a class of individuals whose multifarious duties embrace a no inconsiderable share of civil engineering—he flatters himself it will prove more serviceable.

The concluding article, on the coal owners' compact, was an after thought; induced by witnessing the deplorable state to which the trade has been brought, after a twenty-six months open vend; and urged by the desire to add a few suggestions, to those previously offered by others, in the (perhaps vain) hope of contributing to its amendment.

Newcastle-upon-Tyne,

July 8th, 1847.

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INVENTIONS,

IMPROVEMENTS, AND PRACTICE

OF A

COLLIERY ENGINEER,

&c.

UPON my first settling in the neighbourhood of Newcastle-upon-Tyne, the latter end of the year 1811, as the General Manager of Bewicke Main, or Urpeth Colliery, my earliest attention was drawn to the consideration of some easier method of shipping coals than that which was then in general use below Newcastle Bridge, viz., by spouting them from the waggons into the ships. No delivery of the same kind existed on the Wear at that period, the whole of the coals exported from that River being carried down in keels and cast on board the ships; and, as to the Tees, Hartlepool, and Seaham, they were none of them coal shipping Ports; the last named not having been even so much as thought of until many years afterwards. The method of spouting, then in practice, was much more injurious to the coals than the modern spouts are, which, affording the accommodation, of a series of tiers, provide infinitely better for the rise and fall of the tide. At the Bewicke Main Staith, at Moody's Quay, the perpendicular space passed through by the coals from the waggons into the ship, at particular periods, was as much as 36 feet. The Wear High Main Seam was then in course of working at Urpeth Colliery, and lying under a light cover, was very tender, but good in quality otherwise. Size was of the utmost importance to its value, and no

pains were spared at the colliery to produce the coals in good condition, although the small extracted by skreening—to the amount of a third—was then unsaleable, and obliged to be destroyed in burning heaps. But after all, what was done at the colliery by so serious a sacrifice, was almost wholly undone at the staith by the destructive mode of shipment. My partners—who were from London—were almost petrified with astonishment, when, seeing the great pains taken previously to give the coals the advantage of size, they witnessed the deteriorating result of the final delivery into the ship. After much reflection, the only means which appeared to me to hold out some prospect of relief, was the bringing the waggon into nearer proximity with the ship, prior to discharging it of its contents, and in furtherance of this object, I conceived the design of the coal crane, or drop, as it is commonly designated.* The following is a

* It is due to the late Mr. William Chapman, Civil Engineer, to mention a rather singular coincidence which happened in reference to the coal crane. I had, shortly before, (viz., in the month of November, 1811) become acquainted with that gentleman, when, on occasion of his calling upon me one morning while I was in lodgings in Newcastle, he found me at work upon a drawing, and inquiring what I was about, I put the sheet into his hands. (this drawing is still in my possession, and bears date the 22nd February, 1812) I saw at once that it attracted his attention rather strongly, and he presently remarked in words something like the following, viz., "that it did not surprise him in the least to see that the same train of thought and reasoning had operated in both our minds, on this subject, or that the existing evil should have led to the same resulting cure, so far as principle applied." He then related how he had taken out a patent for a machine for lowering waggons from the spout-head, and that he had erected one at Benwell Staith, but its operations not satisfying the owners of that colliery, it was abandoned. He invited me to go and see it, which I did the following day, accompanied by himself. How long before this, the trial had been made, I do not now recollect; but from its dismantled state, and general appearance, it must have been some length of time; it was, however, easily understood. A cradle, suspended from the top of a pair of sheer-legs, received the coal-waggon—they were passed a few feet forward—that is, the legs, cradle and waggon—to a point perpendicular over the middle of the keel, where the two latter were run down by a combination of ropes and pullies, under the check of a counter balance weight, and the government of a break, to the destined point of discharge; and, when relieved of the coals, were returned, by the re-action of the counter balance weight, to the head of the sheer-legs, and the whole were, finally, moved back again to the original position, by the influence of the same weight. The staithman explained the *causes* of their giving it up after doing scarcely any work. It appeared that there was a complexity in the operations of the machine that made it tedious and troublesome to manage—that the cradle and waggon, when down at the keel, hanging by ropes, were unsteady, being acted upon by the wind—and that the whole business took up too

description of the original machine as erected at the Bewicke Main Staith, Moody's Quay, and set to work in the month of August, 1812.

THE FIRST COAL CRANE

For loading ships from the waggons by lowering them close down to the hatchway, and thereby preventing a great breakage of the coals, which the previously existing mode of spouting subjected them to, is represented in Pl. I, Fig. 1.

The sheer, or drop, legs are connected with the main transverse shaft of cast iron, by two pair of double folded, four by one inch, flat ropes, which lap on two drums, and have each their respectively varying lengths regulated by adjusting sheaves, around which the folds pass for that purpose. The first lap of each fold, taking up a length of 8.63 feet of the pair. The second lap takes up 9.69 feet. The third lap 10.71 feet; and the fourth lap, which brings the cradle to its represented position, takes up 11.78 feet of double rope; which makes, altogether, a length of 40.81 feet, to take the cradle and waggon, from the ship's deck, as shown in the drawing, to the elevated point of departure. A

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much time. This trial had been made through the instrumentality of the late Mr. Buddle, who was the viewer of the colliery. No attempt, I believe, had been made to remedy any of the alleged objections; neither did Mr. Chapman, that I am aware of, ever afterwards try it again in any revised form—indeed, he at once, and in very decided words, after seeing my plan, stated his confidence in its perfect applicability to the purpose intended. It would be a source of great pain to me to state anything that would, by possibility, be supposed to detract from that gentleman's deservedly-acquired fame as a mechanic. We were on terms of intimacy and friendship from our first acquaintance to the time of his death, and no one admired him more for his genius, or esteemed him more highly for his private worth, than myself. The truth is—and he would himself have declared his belief in it had he been living—that not only was my scheme conceived and perfected, without the slighest knowledge of his plan; but that the two designs differ very materially from each other. I have been led to this lengthened statement in consequence of seeing in a work on the Coal Trade, by Mr. M. Dunn, the invention of the present Coal Crane given to the late Mr. W. Chapman.

spiral wheel, on the main shaft, contains the coil of the round rope of the counter balance weight, when the cradle and waggon are at the ship's deck. In the figure, the rope is off the spiral, hanging by its attached end, and the weight in the stapple is at its lowest point of depression. In its ascent, the spiral is so formed, as to cause it (the weight) to pass, successively, each revolution, first 5 feet 6½ inches, second 8 feet 7 inches, third 10 feet 10½ inches, and fourth 12 feet 2½ inches; making, when added, a total ascent of the weight of 37 feet 2½ inches; and the same perpendicular descent of the head of the sheer-legs from which the cradle is suspended, is passed through by the waggon in the course of performing the said 4 revolutions of the main shaft; for the distances measured upwards by the weight are correspondent to the several sines of the arcs described by the descending head of the sheer-legs. The completion of the four revolutions brings the head of the sheer-legs to a point 5 feet below the horizontal line of their base centre; and the resting rail of the cradle still 9 feet lower; a depth, which it was never found necessary to sink the waggon to, by several feet. From the base centre of the sheer-legs, to their top centre, is 34 feet, the latter being advanced 10 feet from the perpendicular of the former. A spur wheel on the main cast iron shaft, 8 feet 9 inches diameter, works into a pinion 1 foot 9 inches diameter on a short counter shaft, upon which also is wedged the break wheel, 8 feet diameter, for regulating both the downward and upward movements of the waggon. The spiral begins at a radius of 7⅝ inches, and finishes each of the 4 revolutions, with the following radii, viz. 1st revolution 13½ inches, 2nd rev. 19½ inches, 3rd rev. 22¼ inches, and the 4th rev. 24⅜ inches. The double folded flat ropes begin their laps on rolls of 2 feet

7 inches diameter. The counter balance weight was 53 cwt., being 26½ cwt., less than the total average weight of the descending load, (the waggon at that time being considerably lighter than at the present period) and 26½ cwt. more than the medium weight of the returning empty waggon, or thereabout, the differences being compensated by the break. The weight was of cast iron, 30 inches diameter, and 32 inches inches high=22,592 cubic inches, or 53 cwt.

As a machine, the combined movements of this crane were so well adjusted as to produce the greatest steadiness in its operations; and the general result of its performances afforded the utmost satisfaction. So great, indeed, was the saving to the coals found to be, that it was, soon afterwards, determined to erect a second crane in the place of a still remaining spout. The experience I had gained, enabled me, now, to simplify and improve the machine very considerably; which I shall proceed to a description of.

THE SECOND COAL CRANE

Erected at Bewicke Main Staith, Moody's Quay, was got to work in the month of August 1813. The mechanism of this machine, which is shown Plate I., Fig. 2., differs from that just described; and having been very closely followed by the coal trade, generally, through a course of more than thirty subsequent years, it cannot but be considered as tolerably perfect. The difference consists in the adoption of one shaft instead of two, and the dispensing with spur wheels—the connection of the sheer-legs and the shaft by means of two single ropes, in place of two double folded ones with sheaves; and the substitution of

two radius arms of wood, with each a weight, in place of the former counter balance weight, pulley, and spiral wheel. The main sheer, or drop, legs are exactly the same as those of the first crane, and the counter balance weight arms are the same length from the centre of movement to the centre of suspension of the weight, viz., 34 feet; and their first positions are also correspondent, being 10 feet advanced at the extremity from the centre of motion. The ropes, connecting the lower ends of the balance weight arms with the outer ends of the transverse shaft, and those forming the communication of the head of the drop legs with the main shaft, are flat ropes of 6 strands each, and 1¼ inch thick,* each one lapping on itself, and beginning with a roll 23 inches diameter, and ending at a diameter of 34 inches. The counter balance weights are each 26½ cwt., being of cast iron, 24 inches diameter and 25 inches high, and measure 11,300 cubic inches. The diameter of the break wheel is 16 feet, and although of inferior power to the other, it has perfect command over the movements.

The action of the machine will be self evident from a view of the figure, as will also be the corresponding positions of the waggon and the counter balance weights which are in perfect agreement with each other throughout their movements. It remains only to add that this crane was less costly in its erection, and proved less expensive in the tear and wear of ropes.

The next coal crane of this description, was erected at Wallsend, for Fawdon Colliery, in the Autumn of 1814, soon after which they began to be generally adopted.

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* These were, I believe, the first 6 stranded flat ropes that had been made.

THE THIRD COAL CRANE

Is a variety from both the preceeding ones, being expressly designed for shipping the contents of half chaldron waggons made use of on the Brunton and Shields Railroad.

This machine is shown Fig., 3., Plate I., four of which were erected in the year 1826, for Fawdon and Wideopen Collieries. The banks of the Tyne are generally so high above the river as to require the intervention of self acting inclined planes for running the coal waggons down to a convenient elevation for delivery to the ships, either by spouts or cranes. In this case the nature of the bank was such (the locality being Percy Banks —between Howdon Pans and Hay Hole) as to render necessary a plane 283 feet long, with a declivity of 3.63 inches in the yard=1 in 9.91—down which a single half chaldron waggon, only, was passed at a time, with a rider to break it, having a very light flat rope attached, which, passing over a wheel at the head of the plane, was doubled back, and brought close beneath the gangway of the geers, for some little distance, to a roll, so placed, as to afford a suitable rise and fall to a counter balance weight suspended from its axle. This weight was of such magnitude as, with a diminished roll and leverage, to be a medium between the loaded and empty waggon; so that the passage down the plane of the loaden waggon, run the weight up to its determined elevation, which, in turn, by its re-action, brought the emptied carriage back again. The waggons were of a different make from the old hopper bodied chaldron waggons, and were discharged at their fore-ends, *vide* drawings, Fig., 4 and 5.,

Plate I., of which a description is given in the next following article. The dog at the end of the rope—by which it was attached to the waggon—had a hook on its under side, which inserted itself into a link affixed to a broad flat rope, as it moved along, some 5 or 6 feet short of the turn of the rails downward, for the purpose of giving the waggon an inclined position of about 45° in order to its discharge. At the moment this situation of the waggon was attained, the sneck of the door was raised by the action of a lever, which the pressure of the load influenced, and the coals were at once spouted out into an iron hopper in two vertical parts, suspended from a pair of legs, in such a way, as to permit of a free separation, when required, by liberating the catches which held them together, upon the hopper's arrival at the ship's hatchway, and thus delivering the coals into the vessel's hold. The broad flat rope alluded to, with its link, stretched out on a bench of wood, so as merely to admit of the waggon's axles passing over it, was attached to a flat surfaced wheel underneath, 3 feet diameter, going nearly once round it. This wheel had an arm and weight, wedged on its axle, pendent when at rest, but raised to a horizontal position by the movement of the waggon to its inclined place, through the agency of the broad flat rope, link &c., the purpose of which was not only to raise the waggon again by its re-action, but to regulate its previous descent. The motion of the loaden waggon from the head of the inclined plane to this, its final position, was never previously stopped, being merely checked some 10 or 12 feet short of it; and the emptied waggon, again, on rising, did not cease a continuous movement until it had reached a siding on the top of the bank, being detached from the rope, while running, only, at the head of the plane. A transverse cast iron

shaft, overhead, carries a break wheel, 14 feet diameter, for regulating the movements of the hopper, and also three coils of flat ropes, one leading to the head of each radius leg of the drop, and one to the radius arm of the counter balance weight. The two legs are 25 feet long from the centre of the base shaft into, and upon, which they are inserted and framed, to the centre of suspension of the hopper, which is 9 feet 9 inches in advance of the face of the front pair of geers, and 15 feet higher than the centre of the base shaft of the drop legs, and which point also is 14 feet from the before named front geers, when the drop legs arrive at their extremest, or horizontal, position; at which time they are 3 feet above the high water line of spring tides. The counter balance weight, is 29 cwt and is hung to a single radius arm, being the same length, and occupying precisely the same position, as the drop legs, and, consequently, describing a corresponding arc (the versed sine of which is 4 feet 3 inches), and preserving an uniform balance throughout the whole action of the machine. The hopper is made of sheet iron $\frac{3}{16}$ of an inch thick, and is 5 feet square at the top, as well as to the depth of 2 feet 3 inches, whence it tapers, from front and back, at a further depth of 2 feet 3 inches, to an edge, 5 feet long in the transverse. Thus, its solid content is 84$\frac{1}{3}$ cubic feet, to receive half a chaldron of coals, measuring 62 cubic feet. But the statute weight is commonly exceeded, and the hopper being lined with one inch fir boards (within the stated dimensions) to save the coals from breakage, the surplus capacity is not greater than is convenient to hold them safely. The hopper is divided, from along the bottom edge upward, into two equal and corresponding parts, each of which are hung from the opposite ends of two short iron beams, the points of suspension being so far inward from the centre of gravity, as to incline their bottom edges pretty smartly

toward each other, for the convenience of self action in closing, when discharged of coals; and the middle of such short iron beams, form common centres of suspension by the drop legs, and the attachment of the two flat ropes leading to the main iron shaft. The catches, which were liberated by a stroke from a man on the ship's deck, fasten of themselves when the two halves come together.

No machinery, or other device, for delivering coals on shipboard, can work more pleasantly, or more economically, than the crane which has now been described. And although, to experienced shippers of coal it may, probably, at first sight, convey an impression of tardiness, the operation is, in truth, not one of that nature. Three keels have been readily shipped by this crane in an hour; but for steady work, one half chaldron is easily delivered every 1½ minute, or 20 chaldrons per hour. This rate of shipment can, without difficulty, be maintained, as an average operation, in good and bad weather. The manual establishment to work it, is one person at the head of the plane, to hand the full waggons forward, and run back the empty ones—one to ride, and break them up and down the inclined plane, and deliver the coals into the hopper—and the off putter, who breaks the drop, keeps account of the delivery, and orders any required changes in the ship's moorings—the man on deck is one of the trimmers, who change about, taking the duty in turn, and discharging it free of expense. The rider, thus shipping 2½ keels per hour, for 10 hours, travels over 45 miles of ground, allowing ½ of a mile per hour, on foot, at the head of the plane. The only fault, that I am aware of, connected with this crane is, that it was planted too low in point of elevation. Had it stood 5 feet higher it would have accommodated the largest class of ships entering the port.

A HALF CHALDRON COAL WAGGON.

Figures 4 and 5, Plate I, give a side and end view of a rectangular waggon for holding half a statute chaldron of coals, such as are used on the Brunton and Shields Railroad, first for the collieries of Fawdon and Wideopen, and next for that of Seaton-Burn; the two former being on the Hazlerigg mines, the property of Sir Arthur Hazlerigg, Bart.; and the latter, carried on by Lord Ravensworth and Partners. These are the waggons referred to as in use for shipping coals by the crane last described. The length, internally, is 5 feet, the width 3 feet 6½ inches, the depth to the soles 3 feet, and 2½ inches thence to the bottom—the width within the soles being 3 feet 4½ inches, and the length the same as above. The gauge, calculated by these dimensions, above the soles is 102,000 cubic inches, added to the bottom portion below the top of the soles, 6,075 inches, together, make the total content 108,075 cubic inches, or 628 cubic inches (0.36 of a foot) more than half a statute chaldron—the chaldron being 214,894 cubic inches, or 124.36 cubic feet. The following are the sizes of the scantlings. The soles 6 feet 6 inches long, and 4½ by 4 inches. Top rails, 3 by 2½ inches. Upright sheths 3 by 2 inches. Bottom end sheths 7 by 3 inches. Bottom middle sheths 4 by 3 inches. Bottom cleading 1¼ inch thick. Side and end cleading ¾ inch thick. Door 1⅛ inch thick, and battens the same thickness. The whole of the framing, of oak; the door of oak also; the bottom of beech; and the side and end cleadings the same, laid on in widths of 4 inches. The soles and the bottom sheths are let ⅜ of an inch into each other,

which brings up the latter ¾ of an inch within the former, and being cleaded with 1¼ inch boards, leaves 2½ inches thence to the top of the soles.

The axles are forged to 2½ inches square, flattening down the angles until they are reduced (between the collars) to nearly an octagonal section. The journals are 2½ inches diameter with 4 inch running bearances, and inside check collars ½ inch broad, and raised ⅜ of an inch. The distance between the collars is 3 feet 2½ inches, leaving ½ inch clear space on each outer side of the collars (together 1 inch), and the cods or carriages, which are 4 inches broad, the same as the soles, making a width of 4 feet and ½ an inch over the soles. The wheels are 2 feet 2 inches diameter across the trod, and 2 feet 3¼ inches over the crest. The extreme width—trod and crest—is 3½ inches. The nave is 5½ inches long, projecting equal distances (1 inch) from each face. The inside square is 3¼ inches, allowing ⅜ of an inch (all round) for wedging, the ends of the axles which are 2½ inches square. The nave is 6½ inches diameter, divided, hooped and keyed, and the rim case hardened—*vide* article on case hardened waggon wheels,—The width over the soles, as before stated, is 4 feet and ½ an inch; to this is to be added ¾ of an inch between each sole (or cod) and nave, or, together, 1½ inch; 1 inch projection of nave within the crest, or in all 2 inches; and ⅝ of an inch for the thickness of each crest, or, together, 1¼ inch; making altogether, a width of 4 feet 5¼ inches, which leaves ¾ an of inch clear, for play, to make up the width of the road within the rails, namely, 4 feet 6 inches. A pair of connecting eye plates are well screwed to the bottom sheths at each end of the waggon, and a jointed coupling bar is secured in the back pair, of such a length as to allow the sole ends, on the stretch, to be 6 inches a part. If a coupling chain is used instead of a jointed

bar, (which in many respects is preferable) especial care should be taken to insure its being securely hung up, when not in use, or great mischief may be done by the breakage of sheaves, if inclined planes are in the way, for at one end of every train there will be such a chain, or bar, out of use.

When a loaden waggon is dispatched from the inclined plane head at the staith, the keep over the door latch is turned back upon the guide as a rest, to admit the lifting of it for the purpose of discharging the waggon of its contents, as described in the last article; and the door is closed, and the keep restored to its place, at the plane head when the waggon is returned thither. In the years 1825 and 6, when these waggons were first made, and when they were somewhat less substantial than the sizes of scantlings herein stated, make them to be, their cost was, cast iron £3. 16. 7¼—malleable iron £4. 7. 4.—wood and making £3. 7. 4½, together, £11. 11s. 4d.—weighing, cast iron 5. 1. 25., malleable 2. 1. 10., and the wood 5. 0. 18., total weight 12cwt. 3qrs. and 25℔. The cast metal was then charged 14s. per cwt., and the malleable iron 4d. per ℔. In 1841, a great number of these waggons were made for Seaton Burn Colliery, by contract, at the price of £9. 10s. 0d. delivered

TRANSFERRING MACHINE.

This coal crane, or transferrer, was projected by me, for the purpose of lifting boxes, holding a chaldron of coals each, by means of steam power, out of keels, and delivering them on shipboard. Fig. 6, Plate I. is a brief representation of the machine. It was intended to have been erected in the year 1818, at Fairless's Ballast Quay, South Shields (now occupied by the Pontop and Shields Staiths), for the use of Fawdon Colliery, then

shipping its coals by the aid of keels, which took them in at Scotswood; but the scheme was not carried into execution.

The subject of this design had occupied my mind for a length of time previous to the period referred to, with the view of giving some relief to the keel delivering collieries on the Tyne and Wear. At a Wear coal trade meeting, held at Chester-le-street, in the summer of 1817, at which I was present, the subject of carrying coals down the Wear in boxes, and delivering them into ships by engine power, was discussed, and although the idea was thought lightly of, by some persons present, it was generally deemed to be a practicable and desirable project. The late Mr. Thomas Croudace appeared to be very favorably impressed with the advantages which the plan held out, and signified an early intention to try the experiment on behalf of Mr. Lambton—the late Earl of Durham. He called to his aid Mr. Burlison, a mill-wright of Sunderland, who carried out his wishes in a manner greatly to his credit; and I by no means offer my design in competition with his, for I consider his, a better thing, although I believe mine would be less costly. My project was brought out only in the shape of a good sized working model, and was thought, by all who saw it operate, to do everything that could be desired of it.

In the drawing Figure 6, Plate I. the pullies *a* and *b* are placed respectively over the middle of a keel and a ship. They are 4 feet diameter (6 or 7 feet would be better) and are hung upon a strong doubled stiled jib, and tapering from 18 inches square to 12 inches, having side stays, and, together, mounted on a wood axle, 18 inches square, and 20 feet long; with four bearances, viz., two circular, near the main stiles, with keeps; and two semi-circular, as bearers only. The stiles were 24 inches apart from end

to end, and form an angle of 55° with the perpendicular. From the centre of the wood axle to the first pulley, was 25 feet 6 inches, and from centre to centre of the pullies 30 feet. A pinion, upon the engine shaft, is placed between two 8 feet spur wheels, being $\frac{1}{7}$th of their size; and which two spurs turn loose on their shafts. With each of these, there are, a break wheel, 7 feet 9 inches diameter; a drum, or flat, rope wheel, 2 feet 4 inches diameter; and a paul, or ratchet, wheel, 1 foot 8 inches diameter; all wedged on their respective shafts; and a sliding clutch placed between the near end of each shaft and its spur wheel, to act upon the same, Flat, six stranded ropes, *c* and *d*, are applied to each drum, and, going respectively over the pullies, *a* and *b*, are united to the middle of a cross bar, which spans the coal-box, and from the ends of which, rods reach down and hook into, the suspending links of the boxes.

The working of the machine was as follows. The clutch of *d*, rope shaft, being slided into its spur wheel, (the engine in motion), caused the lifting of a loaden box, perpendicularly, from the keel, to an elevation which would allow of its swinging pretty closely down to the ship's hatchway, describing the curve represented by the dotted line *f* when (both clutches being slided out of geer) its position will be that described by the dotted lines, with the rope of *a* pulley at *e*. The other drum of rope *c* would also be put in action, so soon after the former, as to insure its being tightened sufficiently, (but no more,) to carry the box in its last named position; which elevations, a little practice would soon teach the engine man to be master of—the break regulating all movements influenced by gravity. Or, a somewhat different course might be taken—*c* and *d* ropes may be put into operation at the same time, when an inclined ascent will be the result, from their combined operation, bringing

the box into the situation, represented, about midway between the two wheels, from whence (the clutches being slided back) it may be swung, by the break *d* into the pependicular position under *a*. The box is then discharged of its contents, from the end, by giving it an inclination of 45°, through the following means. Rope *h* (or a small linked chain) being hooked to the back bottom sheth near to the sole, and passed over a small, deep grooved, pulley, affixed to the near side of the jib, is carried down alongside the same, either to a hand winch, or the rod of a 7 inch steam cylinder—the latter being preferred, as quicker and easier for the man. The box, however, will be so nearly balanced on its suspending links, that a small power will bring it to the required position, either by the application of the man's hand to the winch, or the cock of a steam pipe leading from the boiler to the 7 inch, bottomless cylinder, above the piston.* A keelman would be in waiting on the ship's deck, to hook on the small rope (or chain), as well as, afterwards, to disengage it, and to free the catch, and fasten it again. Two other men in the keel would hook on, and send away, the boxes, and also return them to their places. The sending back the emptied box, is a reversal of the movements which carried it (loaden) to the ship's deck.

Although the descriptive account of the transferrance, may appear lengthy and complex, the whole operation was extremely simple, easy, and quickly performed.

It was intended to raise the jib into nearly an upright position, when not in use, by carrying inward, the two ropes, and hooking them, unitedly, to the lower end of the jib; then setting the rope *c* in motion, by the engine, until it was lifted to the required elevation.

* The steam being high pressure and acting on the 7 inch piston.

A CHALDRON KEEL BOX.

Figures 9, and 10, Plate I, give side and end views, and Fig. 11, shows the mode of fastening the door of this box on an enlarged scale. The length, at the top, inside, is 7 feet, and at the rail from which the door is hung, and thence downward, the length is only 6 feet 9 inches. The width, is 4 feet 1 inch, from top to bottom; and the depth 5 feet. The soles are 8 feet and $\frac{1}{4}$ inch long, and 6 inches deep by 5 inches. The top rails, and all the upright sheths, are $3\frac{1}{2}$ by 3 inches. The bottom sheths $4\frac{1}{4}$ inches square. The bottom cleading, the door, and its two battens, $1\frac{1}{4}$ inch thick; but all the other cleading is of sheet-iron. Oak, alone to be made use of. The suspending bars 3 inches by $\frac{5}{8}$. The side bars 2 by $\frac{1}{2}$ inch. The hinge bolts $\frac{3}{4}$ inch. The hanging bands 2 by $\frac{1}{2}$ inch. This was the box designed for the keels.

A COAL STAITH.

Figure 7, Plate I, is the transverse section, and Fig. 8, the ground plan, of a coal staith, or dépôt, which I erected at Wallsend, for Fawdon Colliery, in the year 1814.

The structure was placed at such a height above the river (viz. about 24 feet higher than spring tides) as to bring the floor of it a little above the level of the spout heads, so as to admit of the waggons, filled therein, to be run along the geers for shipment, intermixed with those coming with fresh coals from the pits. This arrangement, was a new one, and was brought, into use, two years before, for Bewicke Main Colliery. The old mode of depositing coals, was in buildings, erected on the same quays with the spouts,

from which they could alone be delivered into keels, by means of wheel-barrows. This latter plan of depository and re-delivery, originated with the period when keels alone were the medium of shipment. Notwithstanding, however, the unfitness of the arrangement, for a colliery delivering its coals at once into ships, it was never deviated from, nor modified in the slightest degree, until I made the change for Bewicke Main Colliery in the spring of 1812. The owners of Nesham Main Colliery, who made a waggon way to Sunderland, from their pits near Newbottle, were the first to follow the example, a year or two afterwards. At that time, horses were almost solely used for leading coals; and as it was a thing of some importance to keep them regularly employed, a dépôt became a necessary convenience; not only because it greatly aided that object; but, also, that it afforded an increased power of shipment, when called for, which was *then* felt to be a matter of no little consequence, as dispatch, in loading ships, was often an inducement to fixing them. Besides, ships sailed and arrived, more in fleets, than now, when they can always go out, or come into port, by the assistance of steam tugs. The greatly increased powers of leading, however, by mechanical means, in the present day, afford such facilities of dispatch, that dépôts, are hardly ever thought of.

The general arrangement of this building, is simple, and so designed, as to economise space; for it will be seen, that there is no waste, or lost room; as the coals, by their run, fill every part without the expense, and destruction to them, of trimming; as was the case by the old practice.

From the floor to the top of the beam, or crown tree, is 24 feet, and the width there, outside the legs, is 12 feet. The width, within the walls, is 48 feet, and the height 6 feet to the wall-plate. The walls, inside, are perpendicular; and outside, slope

inward from a thickness of 2 feet 9 inches, (besides the footing) to 2 feet 3 inches. The main legs rake, 1 inch per foot inward, and are tenoned into a cap piece, 9 feet above the crown-tree. The side blades, and also the coupled rafters, slope to an angle of 45°. The sizes of these timbers are as follow:—main legs 9 inches square, but reduced, above the crown-tree, to 9 by 6. The longitudinal sylls, which run over the crown-trees, for carrying the waggons, 10 by 7 inches. The struts 8 inches square. The blades, 10 by 3 inches. The caps 9 by 6 inches. The ribs 6 by 3 inches. The rafters 3½ by 2½ inches. The ridge piece 6 by 1½ inches. The wall-plate 11 by 2 inches.

The stone blocks on which the legs are footed, and let 2 inches in, are 2 feet square and 1 foot thick.

The coals, trimming themselves to an angle of 45°, will give ($48 \times 6 + 18 \times 12 + 18 \times 18 = 828 \times 10$ and $\div 124 =$) 65.96 chaldrons, Newcastle measure, for the content of every 10 feet of the length of the staith, which is the distance from middle to middle of each pair of geers.

It answers best to erect two of these structures together, with a communicating foot gang way, from one upper road way, to the other, crossing about mid-length; which will be found a convenience when the delivery is so great as to require the *teeming* into both buildings at the same time. The shortening of the length, one half, by constructing them double, lessens, so much, the space to be travelled over. Double the quantity, also, in a re-delivery, can be effected.

The situation for this staith, should, if possible, be chosen so as to admit of an "on-gate" level with the upper road-way. If this cannot be done, the access to the upper, or *teeming* floor, must be made as easy as circumstances will admit of. A good waggon horse

will draw a chaldron of coals up an on-gate rising 1 inch in the yard. This is nearly double the commonly rated power of the animal; but he is perfectly competent to the task, without being, in the least degree, distressed, for the short distance which the case would require. The on-gate of the Bewicke main staith possesses this ascent, and has been so worked, for upwards of 34 years, without inconvenience. There are, however, but few river-side situations, either on the Tyne or Wear, where the accommodation spoken of, cannot be obtained. The staith, just now referred to, viz. Bewicke (now Pelaw) Main, was made of the length of 600 feet, to suit a particular situation; extending close alongside the waggon way. It was 12 feet high, from the floor at the on-gate entrance, and 18 feet at the lower end, or off-gate, the upper road-way falling $\frac{1}{4}$ inch in the yard, and the floor of the building $\frac{8\frac{1}{2}}{100}$ of an inch in the yard, having entrances at both ends, and a single line of waggon way running through it, for filling the waggons upon.

COAL SKREENS.

Figures 12 and 13, Plate II, being a Plan and Section. When I first became acquainted with the Newcastle Coal District, the skreens for separating the small from the larger coal, to make them marketable, were of a bad construction, and very injudiciously arranged. They were short in length, and to compensate for this defect, the spaces between the bars were generally much wider then than they commonly have been since, upon the length being extended. Another evil existed which virtually made their length still shorter. This was the fixing their lower ends on a level with the top rail of the waggon, placed close, broadside, or

endwise on, to receive the coals. The body of the waggon held 92.53 cubic feet (*vide* article, Chaldron Waggon) and there was, consequently, a heaped top measuring 31.83 cubic feet; and but little more than two thirds its load had been received by the waggon, before the run from the skreen was obstructed, and the coals lay upon the bars, backing a considerable way up the same, and requiring to be raked, or shovelled, downward; the effect of the proceeding being to cause the coals to be passed over the skreen in a body, without extracting more than an inconsiderable portion of the mere small; but, by reason of the wider passages between the bars, taking out a quantity of valuable coal. Thus, while a certain portion of merchantable coal was lost, by going through the skreen (for at that period the small sold, bore but a small proportion to that which was destroyed in burning heaps), much of that which was really injurious—the dead small—went into the waggon. Such were the faults assignable to the skreens themselves, and their general arrangement was equally open to reprehension. At the principal collieries they were most commonly placed with their upper ends toward the pit, forming an array of skreens, right and left, and frequently constituting one *very* widely extended skreen, the waggons being drawn endwise up to them (or it, as the case might be) along numerous branches, radiating from the main waggon-way. In other instances, where, generally, the establishment was on a smaller scale, the waggons were placed broadside to the skreen, and drawn in and out upon one and the same road, occasioning a considerable loss of time. The practice also was to stock the coals in an exposed heap, or, sometimes, though rarely, in a shed, when ships were wanting to take them in, and the staiths happened to be full. This was generally done by running them over the skreens into corves upon trams, which were pushed up an acclivity, formed

of the coals themselves, teemed over and over, until the required height was obtained, when the heap was extended, by the same means, as much as the occasion required—a few planks and tressels being used in the first instance from the skreens until a little elevation was gained. These heaps were filled up again into waggons by hand, when the demand admitted of it; but often in a bad state from rain, and an increase of small, by the action of the atmosphere. Further, the small which fell through the skreens upon the ground—and for which there was, generally, at the time I speak of (1811 and 1812), a very small demand—was either wheeled out by men with barrows, or put out in corves to a lying (though commonly burning) heap, or filled by hand into waggons for sale.

All these drawings, in and out, of the waggons—to, and from, the skreens—to, and from, the heaps—and to, and from, the small coal beneath the skreens—were done by men and horses at, of course, no trifling expense. The whole scheme of the pit bank arrangements was replete, indeed, with inconvenience and heavy charges.

The first alteration which I made, in reference to these pit bank operations, had for its object the dispensing with waiting on men and horses, by running a bye-way past the pit to a point which would admit of a sufficient number of empty waggons to rest upon, as was commensurate to the work carried on; the acclivity of the road being $\frac{3}{8}$ of an inch in the yard. From this place of rest, the waggons, singly, or in numbers, were handed—impelled by their own gravity—into the main way, which passed close in front of the skreens, and were there stopped, each before its respective skreen, to be loaded, as shown in Fig. 12, Plate II, and when filled, to be again handed forward down the main-way, to the siding for loaden waggons, the fall of the main-way being $\frac{1}{4}$ of an inch in a yard,

from the lowermost waggon *f* in the trading direction of the road, which will amply suffice for the movement, since $\frac{1}{8}$ of an inch per yard is the gradient nearest to rest and motion, or *that* declivity which will just afford motion to a loaden chaldron waggon upon a well laid, straight road.

I also lenghthened the skreens considerably, making them more than twice their former length—indeed I may say thrice, when the flat part at the bottom is added. This enabled me to reduce the spaces between the bars to $\frac{3}{8}$ of an inch, from $\frac{1}{2}$ inch and $\frac{5}{8}$, and not unfrequently $\frac{3}{4}$ of an inch. By this means the coals became well spread out into a thin body, and had the whole of the very small, thoroughly extracted, while nothing of a merchantable size was wasted. I boxed in the underside of each skreen with deals, giving a run for the small withinside to a spout, that delivered them into corves, which were conveyed upon trams to a convenient place to be lifted to the level of the pit bank, by a rope passed over a pulley, to the axle of the rope roll, and having such a proportionate coil given to the same, as would lift one corf of the small coal for every alternate draught up the coal pit; or this, if required, was very easily doubled, by causing the motion to commence with the descent of the empty corf from the top, or pit bank, instead of from the bottom, making the uncoiling of the rope to finish when the corves in the pit were at the meetings; and, during the necessary reversion of the movement, to a re-coiling of the rope, the empty corf being changed for a full one; the latter was landed on the top at the same time as the corves from the shaft, the rope roll being increased proportionately in size, *i.e.* doubled. The corves, landed on trams, were run to the trap, or teemed down a spout into a waggon. A boy sufficed to do all the work required at the

bottom—filling the corves—running them to, and hanging them on, the rope. And one man served at the top, unless the number of corves was great, and the distance to the heap considerable. I afterwards added an under skreen, with bars $\frac{3}{16}$ inch apart, for the purpose of re-skreening the small, and extracting the very dust; a demand oversea having sprung up, and a reduction of duty upon small passed through a $\frac{3}{8}$ inch skreen, having been made by government. The dust (or duff, so called by the workmen) was run to the fire heap, and the nuts, or beans, as they were designated, were shipped oversea in a very excellent state. The first of these arrangements, viz., the alteration of the lines of the railways, the lengthening of the skreens, and the lifting of the small by the drawing engine, were effected in the year 1812, at the D. E. and F. pits Urpeth Colliery; and the addition of under skreens, for making nuts and duff, I first made at the A. pit Ouston Colliery in the year 1815, and its results were very beneficially applied in the following year, under the 56th of George the Third, which allowed the export of such re-skreened coals, at a reduced duty, *vide* remark on the low duty on small coal.

The saving of labour in the first instance, of lifting the small in corves, by the drawing engines at Urpeth Colliery, was very great; and not less was the degree of convenience arising from the general scheme of measures connected with the article now treated of. The coal trade public, though slow at first in adopting these improvements, after some time took them up very generally, and now, I rather think, there will scarcely be a colliery found that has not availed itself of some of them.

Figures 12 and 13, Plate II, are a plan and section, explanatory of the improvements just described, the letters in both

referring to the same parts. *a a*, &c., are the best, or large, coal skreens, with the box underneath. *b b*, &c., the flat portions, also grated, on which the coals are received from the skreens to be cleaned, there being a step, or drop, of nine inches from one to the other; for this purpose a man stands on each side, upon a raised floor *n n* &c., and they afterwards shovel them forward into the waggons, *f f* &c., into which the fall is easy. Sometimes, and particularly at first, I used a wooden tray, placed above the waggon, in lieu of the flat skreen; which, suspended on two pivots, had the requisite inclination easily given to it, to spout the coals into the waggon; but the first is, in every respect, the better plan. *c c* &c., are the under, or small coal, skreens, for re-skreening the small; with their hopper boxes for catching and conducting the duff to the corves, *e e* &c., (in place of which tubs are now commonly used) *d d* &c., receiving the nuts or beans; and which corves are "put" along the tram ways *l m* to the *apparatus* rope at *i*, and being lifted, are either landed at *h* to be run to the fire heap, or on the opposite side, upon the tram way *k*, to be emptied into spout *p*, which holds from 1 to 2 chaldrons, and enables the "keeker" when he places a waggon beneath it, to fill the same at once, having the power to stop the run of small when he pleases. *o o* is the keeker's bench of inspection, and the arrows, on the bye and main ways, point out the working direction of the waggons. The skreens *a a* &c., fall 8 inches per foot (more, if the coals are not of a pretty good size, and less, if they are of a large description), and are 15 feet long, the bars being in six lengths of 2 feet 6 inches; the flats consisting of two lengths. The perpendicular measurements are as follow:—

	Ft.	In.
The fall of the screens (the base being $12\frac{1}{2}$ feet) is	8	4
The drop from the lower end of ditto to the flat part	0	9
The flat skreen covers the top rail of the waggon, and is above it	0	4
The height of the waggons, above the road rails, is	6	2
Height of pit bank above the waggon way rails	15	7
The small coal skreens *c c* &c., fall one in one, inclining to an angle of 45°, and are of the same length as the upper ones. The depth of the pit in which they are placed, below the waggon way rails, is	10	5
Making the whole depth from the pit bank	26	0

The width of the small coal pit, at the level of the waggon way, is 11 feet 6 inches; and at the very bottom 11 feet. The pit bank retaining wall is 3 feet 6 inches at the bottom, and 2 feet 3 inches thick at the top, battering 1 foot 3 inches on the pit side to accomodate the lift of the apparatus, a few counterforts may be beneficially added. The other retaining wall of the small-coal pit, is 2 feet 9 inches thick at the bottom, and 2 feet 3 inches at the top, battering 6 inches on the face, or inside of the pit. The skreens are distant 10 feet from centre to centre of each other, and are 4 feet 6 inches wide across the iron bars. The small coal skreens are 4 feet wide. The main and bye waggon ways are 10 feet distant, centre and centre; and the tram ways *l* and *m* are 4 feet 6 inches, similar measurement.

Figures 14 and 15, Plate II, give the particulars of the skreen bars, with the bottom and middle supporting sheths, adapted, at the

time, to the large coal screens just described; and those used for the small coal screens, only differed from them in being made straiter and narrower.

About the same time with, or soon after, the application of the pit drawing engine, to the lifting of the small coal, (as represented in the foregoing account), I applied the same means to another very useful purpose, which, although of less importance, answered a good end. The practice of running the coals to a heap, when there happened to be no demand for them, has been explained. In that case they were first skreened. The plan which I alluded to was, to put them to the heap as they came out of the pit *unskreened* The height of the pit bank, afforded a considerable depth of teem, at once, to the banksmen, exempt from the extra labour of running the coals up an acclivity; and the small retained in them, was a means of less breakage; and by causing the mass to pack closer, rendered them less subject to the action of the air, and, consequently, to deterioration. When a re-delivery of these coals was required, the lifting apparatus was brought into use—the coals were filled into corves and raised to the head of the screens—undergoing the same process as if they had come up the shaft, being mixed with the fresh wrought ones In the event of no rain having fallen on the lying coals their condition is just as good, and, in every respect as unexceptionable, when delivered into the waggons, as those brought at the same time out of the mine. Not so, coals re-delivered from the skreened heap—the extra breakage by the mode and circumstance of putting them there, and their reduction by the air, were causes of considerable deterioration and waste. If much wet had fallen, the coals, of course, would suffer in both cases; but far more in the latter, for the rain would penetrate through the skreened body, when the compactness of the other allowed it to enter a small depth only.

There was no need of running the corves to the small coal apparatus. The means of lifting them were capable of being erected any where on the heap stead, and as many as three or four of those conveniences were frequently in operation at the same pit. Under any circumstances, the state of the coals, thus re-delivered, was incomparably in better condition, than those filled into waggons, in the other instance; and the admixture of them, with the fresh pit coals, was a thing of no small advantage. In every point of view, whether as saving the coals, as a saving of expence, or as an advantage to their appearance and condition, I have always considered this method of dealing with the resting heap coals, a very convenient and beneficial one.

ROLLY EDGE RAILS.

Figures 16, 17, 18, 19, 20, and 21, Plate II, are plans, elevations, and sections, of the first edge rolly rail ever used—adopted at Ouston Colliery, in the year 1816.

Great as was the improvement of the iron tram plates, introduced by Curr, over the old wood-ways, which had previously served for all underground putting and leading; even their advantages were found inadequate to the purpose required of them when colliery operations began to be much enlarged, and the outputtings of a pit were extended to an amount not formerly dreamt of—between four and five hundred tons, for instance, being drawn up a shaft, upwards of 60 fathoms deep, with a pair of ropes, in twelve hours.* It was a case of this description that drew my attention to the subject of

* This was done at the A. pit, Ouston Colliery, at the time referred to.

underground tram ways, where hindrances, of daily occurrence, exhibited themselves, inseparable from the plan, when in connexion with a great stroke of work underground, where nicety of laying down, and care in keeping the roads, could not be insured as on the surface; but more especially in reference to the horse, or rolley-ways. Tram plates were made use of, both for the boys to "put" upon, from the boards to the crane, and for carrying the rollies, from the latter to the bottom of the shaft; but the former were much lighter than the others. Both were laid upon transverse wood-sleepers, and pinned down with counter sunk headed nails, which afforded no security of holding, for a slight degree of shaking (of which they had necessarily a great deal), loosened them. In order to insure the plates to lie quiet when the carriages (particularly the rollies) are passing over them, the sleepers ought to be well bedded, and quite level on their surfaces, across, as well as longwise. This is rarely the case underground—indeed, on the surface, even, it is no easy matter to preserve their transverse truth. One or other of the edges of the sleeper is generally somewhat elevated, causing the nails to start out; and there is no end to the renewal of them; thus causing a really fearful waste of the article. Wanting the pins, the plates had nothing left to aid their security, but the penning, or other filling, withinside the upright ribs of the plates, guarded again on the outside by the edge rolley wheel. These constituted a very poor dependence, and the consequence was that the plates were continually getting out of place, and the rollies, as often, running off the road and deranging others. From such, and other causes, arising from the general imperfections of a way destined to carry so large a traffic upon it, these interruptions occasioned a serious loss of time, as well as a heavy charge. The loose nails, too, were frequently picked up by the horses, in their

feet, causing sometimes, bad and protracted lameness.* To remedy these evils I designed the edge rolley rail; the advantages of which were speedily attested by the general adoption of them. It will be unnecessary to give a particular description of these rails, the drawings themselves, amply serving all the purposes of a detailed explanation. Fig. 16 is the common rail, 4 feet long, weighing about 31 lbs.—Fig. 17 is the chair, adapted to it, weighing about 2¼ lbs.—Figs. 18 and 19, a pair of point rails for a siding, or parting, also 4 feet long, weighing, together, about 1 cwt. 1 qr. and 4 lbs.—Fig. 20, the crossing rail, same length, weighing 2 qrs. and 14 lbs. Between each point and the crossing rail, 4 common rails are inserted. The clear width between the rails was, in this instance, 2 feet 3 inches. It will be observed, that the ends of the rails are box, or mortoise, formed; and that a stud upon the chair is easily received within the same—half into each rail. A tip is cast on the rail to allow its very extremity, only, to rest on the chair; the virtue of which arrangements—the box, the stud, and the tip—is to keep the rail always quiet and in its place: and the two chairs being securely fastened down, at bank, on each sleeper, by pretty strong trenails (which never draw out) the true, and unvarying, parallelism of the rails, is infallibly preserved; and they never tilt up, on the lever principle, as the tram or rolley plates are apt to do. Thus, pins, or nails, are not required. The chairs being fastened to the sleepers, by the wrights above ground, are correctly done; not those only for the common rails, but those for the point and crossing rails, and others constituting the siding, or parting; thereby saving all the time before spent by the way-

* It happened, during one particular period of 3 months, that 40 horses were thus injured and laid off work at Fawdon Colliery, for longer or shorter lengths of time.

wrights, underground in contriving, measuring, and suiting the plates in (at best) a very obscure light. So great was the facility afforded by this arrangement, that two men were capable of laying down, (and incomparably better,) eight or ten times the length of these edge rails, that they could do of the rolley plates; and when done, they called for very little after attention, and occasioned no hindrances.

Another important benefit derived by this change, was the reduction in animal and manual labour, which arose from three causes, viz., the relief afforded by a more easy traction on an edge rail than a flat plate with a stand up retaining rib; next, the clean state of the one surface compared with the other; and lastly, the saving of the time previously wasted by the various hindrances above adverted to.

On the first bringing of these rails into use in the east way of Ouston Colliery, a fourth part of the horses, previously employed, was dispensed with, the same amount of work being done. The late Mr. Buddle was one of the first to adopt the improvement, and he declared to me that he believed it saved one third of the horses, by one means or other,

Thus were underground edge rails brought into use, and the open, or box, ended rails and chairs first adopted in the year 1816. Rolled rails are now commonly used for cast iron.

INCLINED ROPE SHEAVE.

Figures 22, 23, and 24, Plate II, are drawings of a friction sheave, for curves on planes, where ropes are used; but more particularly for extended operations, in which my patented plan

for the combined, or reciprocating application of fixed engines, led me to the contrivance of in the year 1820.

The rope rollers—as they were fittingly enough called—heretofore used on inclined planes, were heavy, cumbersome, and costly; and very indifferently answered the purposes intended, viz., the lightening of friction and saving the rope. They very often did not turn at all, owing to their great weight, and generally bad condition, which it was no easy matter to remedy; and those that did turn had their surfaces running at a much less speed than the rope that gave them motion, arising from the retarding influence of the friction which they were liable to; the effects of which were to gutter the surface of the roller, waste the rope by rubbing, and add an additional load to the traction. To accommodate curves, vertical rollers, turning upon stalks fixed in blocks of wood or stone, were used, which were loaded, if possible, with a greater burden of friction than the horizontal ones. In a mechanical point of view nothing could well be worse than both these devices.

Connected with my scheme of extended operations, at greatly increased speeds, by means of fixed engines, (which method will be treated upon by a special article,) I felt the necessity of having a sheave of not only less cost, and liable to less friction than those that had been hitherto made use of, but one well adapted to curves. The result was the production of the light and inexpensive sheave, Figure 22, used, as shown, in an inclined position for curves; or vertical for straight lines, mounted on a simple frame of cast iron, also; both being bolted down to blocks of stone. These sheaves are so light that they turn by the slightest touch, and their surfaces run at the same speed as the rope—and if properly fitted up, are little liable to failure or wear.

The friction wheel, Fig. 22, weighs 25 lbs. Its extreme diameter is 15 inches, and the extreme width 4¾ inches. The diameter at the bottom of the groove is 10¾ inches, at which place the curvature should very little exceed the size of the rope. The rim at the bottom is ¼ of an inch thick, tapering to $\frac{3}{16}$ inch where it is edged with a bead ¼ inch diameter. There are 8 arms 1¾ inch broad, $\frac{5}{16}$ inch thick along the middle, and $\frac{3}{16}$ inch at the edges. The nave is 2 inches square, ⅜ inch thick, and 3 inches long. The axle is ⅝ inch square with gudgeons ½ inch diameter, 1¼ inch long at one end, and 2 inches at the other. The sheave in the drawing is represented as inclined to an angle of 45°, which can be increased, or diminished, at will, by giving the requisite position to the stone it is affixed to. The frame is 5½ inches wide within the stiles, which are 3 inches broad by ⅝ inch thick; the base, Fig. 23, is 10 inches by 4½ inches, and ¾ inch thick. The frame, weighing 31 lbs., is bolted to a block of stone, 20 inches square by 10 inches thick, with two ¾ inch bolts. The cost, complete, with the stone block, is about 7s. 9d. The gudgeons of the axles are turned with square shoulderings, and a washer, or collar, 1 inch diamater, and ⅛ inch thick, fitting pretty closely, is put on each bearance red hot, up to the shoulder. The wood stile, for the higher end of the axle to run in, is 3 inches by 2 inches; and the slot, or wood bearing, for the lower gudgeon, Fig. 24, is 2⅜ by 2½ inches, and 1¼ inch thick, shouldered to a tenon 2⅝ inches long (rounded at the end) by 2½ inches broad, and ⅝ inch thick, with a cotter hole as represented in the drawing.

In order to use this friction wheel in a vertical position, two wood stiles, similar to that in Fig. 22 are screwed in like manner to the two upright side pieces (stiles) of the frame, which is bolted

down to a stone block, 16 inches square, by 8 inches thick. The cost of it, thus mounted and complete, is about 6s. 9d. These rope friction wheels, which I brought out 26 years ago, have been universally adopted in this district.

TRAM PLATES.

Tram ways, and trams, though now greatly superseded by the rolled saddle (edge) rails, and the box, or tub, carriages, so commonly and advantageously adopted underground, are, nevertheless, very convenient in many situations, and will, in all likelihood, continue to have a preference, for numerous purposes, in consequence of their simplicity and handiness.

To remedy some of the evils spoken of under the article on rolly edge rails, I designed a new description of tram plate in 1829, assimilated, in some respects, to the rolly rail. This plate with its chair, is given in Figures 25, 26, 27, 28, 29, and 30. Number 25, is the side, and 27, the end view; 26, is the plate turned bottom upward; 28, the end, 29, a side view, and 30, a plan of the chair. The several dimensions are given, in figures, upon the drawings.

The merits of this plan are as follow:—By the adoption of a chair, and the use of feet under the ends, nails (an incalculable evil in such cases) are dispensed with; tilting, (rising up of one end when the other is pressed down) is effectually prevented, and a fixed gage, or parallelism, to the rails, is secured.

The drawings from which the figures have been taken, were originally furnished for a surface way, to carry heavier weights than tram roads, in and about pits, usually bear, and, consequently, they were made stronger.

As movable roads on heap-steads, for filling up, and putting, round coals to the lifting apparatus; or, for running out small coal on pit-banks, where the shifting of the ways is continually required, nothing can exceed a tram-way; and the above scheme, by the facility afforded to the laying down, and other beforementioned advantages, greatly contributes to the convenience and superiority of such a road.

CASE HARDENED WAGGON WHEELS.

Nothing was more common at one period, after the substitution of cast iron for the old wooden rail, than the exhibition of deeply guttered waggon wheels, and no trifling inconvenience resulted therefrom. First, their extremely irregular movement upon the rails, which occasionally suited the gauge thus furnished, and frequently did not—occasionally with the rail in the groove, and then again the contrary—but especially round curves, where the disagreement was greatest, and always certain—the consequence being distortion to the way and an increased draught imposed on the horse—next, the necessity that then existed of casting the wheels from the softest grey metal to insure the better chance of their standing the cooling process, which rendered them more costly in the first instance, and greatly more so ultimately, by their increased liability to wear. Hence arose the threefold evil, of a mischievous effect on the road, an augmented load of traction, and a very great charge in the wheels themselves. These drawbacks on railway economy presented themselves forcibly to my notice, and a remedy for them occured to me in case hardening the rims of the wheels, by forming that portion of the mould in which they were

cast, with a thick hoop of cast iron, and thus chilling the face, or trod, by running the fluid metal in contact with cold iron. I mentioned this idea to my friend Mr. William Losh, of the Walker Iron Works, about the end of 1811, or early in 1812. It struck him, as it had done me, that a benefit would arise from it, and he undertook to cast some wheels accordingly, for our colliery at Urpeth. It very rarely happens that any new, and useful, thing is accomplished at once, and difficulties, and delays, occured in this instance. It could not have fallen into better hands, as Mr. Losh's subsequently successful patents for malleable locomotive engine, and other carriage wheels, attest his knowledge, skill, and perseverance in such matters, and point him out as happily chosen for the purpose.

The first wheels made were cracked in many of the arms. It soon became obvious, that the unequal, and, consequently, the disagreeing times of contraction, was the cause. This was at length remedied by dividing the nave, in the mould, into four longitudinal parts, which were afterwards filled up with four keys, or wedges, and hooped at each end with iron rings put on red hot. By this means the wheel was made perfect, and came speedily into general use—so well indeed was it found to answer, and so highly was it approved of, that the founders for some years charged two pounds a ton extra for them. This method of keying and hooping (which was Mr. Losh's idea) is now very commonly adopted by millwrights for all entire wheels made of crude iron. Indeed a sound casting, of that description, can hardly be insured, unless the nave is divided in the running, keyed and hooped; for it is next to impracticable so justly to proportion the rim, the arms, and the nave of a fly, or toothed wheel, relatively, that they shall cool simultaneously, and contract in precisely equal ratios—the requ[illegible] of some one or more parts demanding [illegible] than a

(otherwise) due adjustment, for the object alluded to, would admit of. Entire wheel castings very often appear sound, nor can the nicest examination sometimes detect an imperfection, and yet, eventually, they prove to have been otherwise—some internal disruption of the particles (caused in the cooling) having left a mere external union. No entire wheel casting can, indeed, be deemed sound, and consequently safe, unless it has been keyed and hooped; and many have been the frightful accidents in rolling mills, by the fracturing of spur and fly wheels, which might have been prevented had this method been attended to. Another, and by no means unimportant, advantage arising from it, is, that a lower, and a stronger quality of metal, can be made use of than is generally thought indispensable for entire wheels—a practice alluded to in the beginning of this article—and which has been so applied to waggon wheels of late years as, by the use of hard metal, to do away very much with the demand for case hardened rims. I applied the case hardening principle to underground rolly and tram wheels, to waggon axle cods, and to the bearings of gudgeons of heavy machinery, for which two latter purposes it is very much to be preferred to brass castings, as being less subject to attrition, causing a diminished friction, and being less chargeable. The surface of iron in the case hardened state is, in fact, analagous to steel when hardened, which is used for the best got up lathes, and for time pieces.

So wonderful is the change in railroad engineering, within the last sixteen or seventeen years, and so great is the speed of travelling which the various improvements have contributed to, that none but malleable iron wheels are now deemed safe for the public railroads, and, consequently, the foregoing subject is not a matter of so much interest at the present day, as it was, at the period, referred to.

THE RECIPROCAL USE OF FIXED ENGINES ON LEVEL AND OTHER PLANES.

I took out a patent in the year 1821, for the reciprocal application of fixed engine power on planes not available to gravity, on account of low gradients, over flat or undulating surfaces, and for distances never before attempted, having been led to the consideration of the subject by the following case.

Upon the Ouston waggon-way, there was a stage worked by horses, situate on Birtley Fell, 1992 yards in length, lying between the head of the Blackhouse, and the foot of the Ayton Banks, engine planes, the ascent from the former to the latter point being 65½ feet, comprised of several gradients. Up this piece of road the coals were led for shipment at the Tyne, and 10 powerful horses were required to do the work. The distance from the colliery to the Tyne was 7 miles, and I had, with the exception of the above stage, subjected almost the whole of it to mechanical treatment by engine, and self-acting inclined planes. The expense of the animal power, upon the portion of the road now referred to, was very heavy, the cost having been for the then preceeding 12 months (1820), £750. 12s. 0d. I had been successful in the application of mechanical devices to other parts of the road, and thereby had greatly reduced the charges, and I was desirous of effecting some means of bringing down the weighty expense of this portion of it. At the head of the Ayton Banks plane, was an engine of 25 horse power, and another of like magnitude was placed at the top of the Blackhouse plane, the distance from one to the other being 2315 yards. The Ayton plane was 323 yards long, and rose 113 feet—the Blackhouse plane was   its rise was 122 feet.

The stage between these planes, already alluded to in respect of length and rise, was not such as to admit of any means of mechanical application, then in use, being substituted for the animal power, as, besides the want of gravitating influence, the line itself was tortuous.

The longest inclined plane I had ever heard of was ¾ of a mile, and a self-acting one. Engine planes were generally much shorter and steep.

These two engines were by no means fully employed—on the contrary, they were at rest more than half their time. It occurred to me that both might be brought into use in working this stage of 1992 yards—the Ayton engine in drawing the loaden waggons upward, and the Blackhouse one in pulling the empty ones down, although they stood 2315 yards apart, and the former on a hill 178½ feet above the latter. To be successful, I was sensible that it would be necessary to run at a speed of about 7 miles an hour, which was more than double any travelling rate on rail roads up to that period attempted—by horse, locomotive, or fixed-engine power—but such speed was indispensable in order that the operation should be made to chime in with the working of the two engine planes. It struck me (at this time) as a thing most desirable, if not absolutely requisite, that rope friction sheaves of a lighter, less expensive, and more effective character, than had heretofore been used, should be adopted; and thus it was that I planned the sheave described page 31. The scheme was speedily carried into execution by merely adding a rope wheel to each of the engines, putting down about 300 rope sheaves, and applying two of the longest ropes ever before manufactured, one of them being nearly 1½ mile long. Six waggons (carrying 16 tons of coals) constituted the train, with a rope attached to each extremity, one active, the other passive; the drum wheel of the passive rope—which was, of course, alter-

nately one and the other—being out of geer with its engine machinery, was left free to turn round by the pull of the uncoiling rope. The engines had still spare time, and nothing could go on more effectively and satisfactorily; and the saving accomplished by the arrangement was the difference of £750. 12s. 0d. the previous charge, and £244. 9s. 0d. the substituted expense, or upwards of £500 a year.

It was not until some four years after this that the rate of travelling attained by this means, was reached by locomotive engines, upon the Stockton and Darlington Railway; but so much as 10 miles an hour, as a maintainable speed, was never speculated upon, until the Liverpool and Manchester project was brought before the public.

Messrs. Walker and Rastrick were employed by the directors of the Liverpool and Manchester Railroad Company, first, to inform themselves on the different tractive means made use of on railways; and next, to report their opinion as to the most advisable power to be adopted for the working of the Liverpool and Manchester Railroad.

Those gentlemen visited all the railroads, I believe, having locomotive engines upon them; and they also examined very fully my plan. This took place in the month of January 1829, at which time the Brunton and Shields Railroad, 10 miles in length, was extensively operated upon by my reciprocating principle. They devoted a considerable portion of their reports* to the investigation of this plan, and concluded by recommending its adoption in the following very decided terms—"with reference to *economy, dispatch, safety, and convenience,* our opinion is, that if it be resolved to make the Liverpool and Manchester Railway complete at once,

* Each of these

so as to accommodate the traffic stated in your instructions, or a quantity approaching to it, *the stationary reciprocating system is the best.*"

They found also that the charges of this system, applicable to the Liverpool and Manchester Railway, would be ·2134 of a penny per ton per mile, and that the expenses of the locomotive system would be ·2787 of a penny per ton per mile. Mr. Booth, the secretary of the Liverpool and Manchester Railway Company, accompanied by several of the directors, visited the Brunton and Shields Railway shortly afterwards, and appeared to be greatly pleased with the operations. The locomotive engine of that period was far from being the effective machine it has since proved to be. The difficulty of obtaining a sufficiency of heating surface in the boiler for raising the almost incredible quantity of steam called for, was the great drawback, and any other improvement was of little moment so long as this desideratum was unattained. Mr. Booth's suggestion of the use of very small brass tubes at length overcame the obstacle, and was the means of rendering the locomotive engine the very extraordinary instrument it has since become.*

* Some idea can be formed as to the prodigious quantity of steam required by a locomotive engine, and of the utter incapability of the boilers first used, to supply it, from the following observations. Mr. Watt laid down the rule that 480 square feet of heating surface boiled off 1 cubic foot of water per minute—*vide* "Interesting and useful information relative to Watt's Steam Engine." By means of Mr. Booth's admirable invention of narrow tubes, a small boiler was made to possess the power of giving the needful heating surface—a case will illustrate the fact. A goods engine on the Newcastle and Carlisle Railway, travelling 11 miles an hour, with a competent load, boils off 1¼ cubic foot of water per minute, the steam arising from which is capable of working a fixed condensing engine of 65·45 horse power, calculated on Mr. Watt's rule of 33 cubic feet of atmospheric steam per minute to each H. P. While, to evaporate such 1¼ foot of water by the best ordinary boilers, two, of 25 feet length and 6 feet diameter, with 2 tubes of 20 inches diameter in each, together with side and bottom flues, would be requisite; the locomotive boiler of 8½ feet long and 3½ feet diameter, being, in cubical content, compared with these, as 81 to 1413 feet. But the passenger trains travel twice and a half, and even three times and upwards, as fast as the engine above quoted, using a proportionately increased quantity of water. How extraordinary then must the waste of power be at high speeds, when an engine realising no more than 45 or 50 horse power uses as much steam as would work a fixed engine of some 150 H. P. It will be seen how inadequate any boiler must have been to the generation of steam for an approach to a high speed in locomotion, prior to the use of small tubes in boilers.

Fortunately, however, for themselves, and the public at large, the Liverpool and Manchester Railway Company decided, finally, on the adoption of the locomotive system.

WEIGHTS AND MEASURES

Of the Coal Trade of the Counties of Northumberland and Durham; the substitution of Stroke Measure for that of the Heaped Waggon; with Abstracts from all the Acts of Parliament having relation to the Coal Trade, from the 6th and 7th William III. to the 56th George III., both inclusive.

In the year 1818, Mr. Smyth, one of the four "General Surveyors" of the Customs, visited the Ports of Newcastle, Sunderland, and Blyth.

During his stay in the district, he caused many trials to be made of the weight of the chaldron waggon of coals, which he personally superintended; and, being forcibly struck by the disagreement of the results, and the still greater want of accordance with the statute measure, he left orders with Mr. John Liddell (an intelligent officer of the Newcastle establishment) to weigh all the waggons that delivered by spout to the ships, and to mark each with the weight he found it to carry. Mr. Liddell was engaged in this duty for many months, during which, he weighed 716 waggons of skreened coals, and re-weighed 181 waggons with re-skreened small, for the low oversea duty. The weights of skreened coals universally exceeded the statute weight of 53 cwt.—and, generally, very considerably so.* At Ouston Colliery, 122 waggons of skreened

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* One waggon at Jarrow Colliery weighed 72 cwt. 0 qrs. 7 lbs.

Hutton Seam, averaged 56 cwt. 3 qrs. 9 lbs., and 24 of the same waggons, with oversea small, averaged 51 cwt. 0 qrs. 21 lbs.—the difference being 9.93 or, in round figures, 10 per centum; which difference corresponds very nearly, as will be seen, with the experimental trials,

The Newcastle chaldron of coals had been always considered as consisting of 24 coal bolls, and such it was deemed to be in all colliery leases. How erroneous this was, will be perceived by the following experiments, made by Mr. John Liddell, with the utmost care, assisted by a party of his own officers, with the Custom House scales, weights, and measures—I was myself present during the whole proceeding.

OUSTON COLLIERY—SCREENED HUTTON SEAM.

Waggon, No. 58.	Cwt.	qr.	lbs.	Waggon, No, 74.	Cwt.	qr.	lbs.
2 bolls ...	4	2	10	2 bolls ...	4	3	6
2 „ ...	4	2	13	2 „ ...	4	3	18
2 „ ...	4	3	2	2 „ ...	4	2	11
2 „ ...	4	2	22	2 „ ...	4	2	15
2 „ ...	4	2	5	2 „ ...	4	2	2
2 „ ...	4	2	21	2 „ ...	4	2	18
2 „ ...	4	2	10	2 „ ...	4	2	8
2 „ ...	4	2	8	2 „ ...	4	2	2
2 „ ...	4	2	12	2 „ ...	4	2	17
2 „ ...	4	2	25	2 „ ...	4	3	0
2 „ ...	4	3	7	2 „ ...	4	2	25
2 „ ...	4	3	1	2 „ ...	4	2	12
24 bolls ...	55	3	24	24 bolls ...	53	3	22
Aver. ℔ boll	2	1	9·16	Aver. ℔ boll	2	1	9·14

FAWDON COLLIERY—SCREENED HIGH MAIN.

Eight Waggons filled with 24 Bolls each, = a Keel.

	Tons.	*Cwt.*	*qr.*	*lbs.*		*Cwt.*	*qr.*	*lbs.*
24 bolls	0	57	0	24	Average per boll ...	2	1	15
24 "	0	56	1	11	" ...	2	1	11
24 "	0	56	1	18	" ...	2	1	11¼
24 "	0	56	3	13	" ...	2	1	13¼
24 "	0	56	3	7	" ...	2	1	13
24 "	0	57	2	1	" ...	2	1	16¼
24 "	0	56	3	3	" ...	2	1	13
24 "	0	57	1	13	" ...	2	1	16

1 keel = 22 15 1 16* Average ⅌ 24 bolls, 56 cwt. 3 qrs. 19 lbs., and ⅌ boll, 265·646 lbs. Numerous experiments afterwards confirmed the above, and the following, therefore, is deducible. The coal boll (*vide* further on) content 9615·346 cubic inches, and weight 265·646 lbs. The chaldron waggon (*vide* chaldron waggon) content 124·337 cubic feet, weight 53 cwt., content in bolls 22·345 or $\frac{1}{14.84}$ less than 24 bolls.

The above measurements and weighings were done in the following manner. The coal boll was filled on the ground, with fresh screened coals, put down for the purpose—it was then weighed and turned over on a wooden platform, and finally cast into a waggon. Mr Liddell and myself accompanied the 8 Fawdon waggons down to the staith, and saw them delivered into a keel, the 8 chaldron marks of which proved to be considerably under water.

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* Eight statute chaldrons being only (53 × 8 =) 21 tons 4 cwt.

STROKE MEASURE.

About this time (beginning of the year 1820), the owners of Fawdon Colliery, who had changed their place of delivery from Carville to Scotswood, (being driven to the measure by some difficulties arising from lessorship), or in other words, from a spout to a keel delivery, experienced very serious inconvenience by the great discrepancy of spout and keel measure. It has been already shown that Ouston Colliery was on an average in excess of (even) the 24 bolls per waggon, as much as 56 cwt., 3 qrs. 9℔s. above 55 cwt., 3 qrs. 23 ℔s., or 3 qrs. 14 lbs; but such collieries as that of Fawdon, working much larger coals, were enabled to heap on much higher tops upon the waggons; and it was very well known that this over measure (or weight) was carried, frequently, by the spout collieries, to an increase of 10 per cent., and very often much higher—to the extent, even, of one chaldron to the keel, or 9 chaldrons for 8. The keelman, on the other hand, would not take in an excess of measure (or weight), but rigidly adhered to their weighed marks, and from which loadings too, considerable pilferage took place, between the staith and the ship. The magnitude of this evil was found to be of such importance to the owners of Fawdon Colliery, who were so well able to appreciate it, that they were not long in determining to appeal to the commissioners of customs upon the subject, and, accordingly, I drew up the following memorial to the board, being an owner, and having the management of the colliery.

Newcastle-upon-Tyne, 18th of April, 1820.

Honourable Sirs,

We the undersigned, Owners of Fawdon Colliery, in the County of Northumberland, delivering coals at the river Tyne, 4 miles above Newcastle Bridge, and having the largest establishment of keels of any colliery upon the river, beg leave to draw your attention to the coal measure at this port.

By the 6th and 7th of William the Third, cap 10. (which is the only statute that has immediate reference thereto) the Newcastle chaldron measure of coals is fixed to be 53 cwt.

The keels, conveying coals from collieries lying above the bridge, are weighed at Newcastle Quay, by the Custom House Officers, and are marked by them, at both the ends, to the draught of every single chaldron; being seizable whenever the marks which indicate the chaldrons they were professedly put off for at the staiths, shall be found under water.

Thus far the act of parliament is completely effective, in relation to collieries above Newcastle, because ships cannot pass the bridge, and, consequently, of necessity receive their loadings by keels, under the restrictions mentioned.

But collieries situate below the bridge, and delivering at once from waggons, by spouts, into ships, are, in fact, under no restraint, short of what it may be possible to heap on their tops, the waggon being held to carry a statute chaldron, although it is capable of holding upwards of a third more than that quantity, and has been found so loaded by the officers of the customs without being considered liable to seizure.

This evasion of the legal measure (or weight) has arisen from the adoption of spouts, and the practice of shipping coals directly from the waggons—a system commenced long after the act of William the Third. The waggons carrying coals from the pits to the river, at that period, were not regarded by the act, because they delivered into keels, which effectually limited the measure, (or weight) and being loaded then with heaped tops, were not calculated for any positive or defined quantity.

Your petitioners desire to state to your Honors that a disregard of the statute measure, by collieries below Newcastle, has, of late, been carried to an extent hardly to be credited; and that, in reality, they are under no control, short of 72 cwt. to the chaldron, in the place of 53 cwt.—that to the present depressed state of the coal trade (which has led to a severe struggle among the collieries) is to be attributed the shameful abuse of the power thus possessed by collieries below the bridge, over those situate higher up the river; and which is particularly hard upon your petitioners, in as much as that they are shut out from a fair and equal competition—and that further, it is productive of loss to His Majesty's revenue—the corporation dues of this port—and to a number of lighthouses and piers.

Your petitioners submit that the Legislature must have intended that there should be one general and uniform measure of coals upon this river, and that the chaldron should in no instance exceed 53 cwt. They beg permission, therefore, to suggest, that the only mode (in their opinion) by which the collieries below

Newcastle can be restrained from exceeding the statute chaldron, is by the adoption of a stroke measure; which might be effected, in the first instance, by your ordering ledges to be added to the tops of the present spout waggons (all new made ones being properly constructed to hold their loads without them) so as to render them capable of carrying 53 cwt., each, with a level surface, confined to such ledges.

When your Honors consider the immense capital embarked in collieries in this district—the great number of men employed in them, and their various ramifications—and that the late strike of the keelman was occasioned by the curtailment of their work, in consequence of the undue advantage gained over them by the spout collieries (as herein has been set forth); your petitioners humbly hope, and trust, that the state of the coal measure of this port will be deemed by your Honourable Board of sufficient importance to call for, and receive, your immediate and most serious attention.

Your petitioners, with all possible deference, beg leave to suggest, that your Honors would be greatly assisted in your investigation of the matter complained of, were you to order before you Mr. John Liddell, a Landing Surveyor of this port, who is extensively experienced in all the bearings of the question.

Your petitioners beg to subscribe themselves,

Your Honors' very obedient and humble Servants,

On behalf of the Owners of Fawdon Colliery,

(Signed) BENJAMIN THOMPSON.

To the Honourable the Commissioners of His Majesty's Customs.

The above memorial was sent by my friend the late Mr. Archibald Reed (at that time Mayor of Newcastle) to his Grace the late Duke of Northumberland, with a request that he would hand it to the Lords of the Treasury. This was at once complied with by the Duke; and from the Treasury it was passed to the Commissioners of Customs, who, shortly afterwards, transmitted it to Newcastle, to be reported upon by the Collector and the Comptroller of the Customs, and the following is a copy of their report.

[No. 300.]

Custom House, Newcastle-upon-Tyne, 25th May, 1820.

Honorable Sirs,

Enclosed, we return the petition of the Owners of Fawdon Colliery, relative to the coal measure on the river Tyne, and beg leave to report that we entirely differ in opinion with the petitioners as to the Newcastle chaldron being altered

from 53 cwt., the legal standard as fixed by the 6 and 7 William the Third, cap. 10. in the conveyance of coals by waggons to the spouts to be put on board ships. The waggons of all the collieries on this river below Bridge being weighed and marked and, as directed by Mr. Smyth, Surveyor, to the greatest quantity they are capable of containing; therefore in shipping coals by waggons on board vessels bound to Foreign Ports, the tidewaiter notes in his book and on the sufferance the number of every waggon and the weight it is marked to carry, and when the loading is completed the weights are totalled and then reduced to chaldrons of 53 cwt. each; and with respect to the shipping of coals coastwise, we are fully convinced that the instances are very few in which fitters have granted certificates for a lesser quantity than actually shipped, as on reference to some hundreds of returns for vessels delivered at London, we find that they generally make out in due proportion, which we humbly submit is a sufficient proof that frauds are not pactised on the revenue as stated by the petitioners. We are however aware that little unintentional inaccuracies will (so long as coals are shipped by weight end delivered by measure) occur in the granting of certificates for the shipment thereof coastwise, which probably might be avoided if that part of the Act 52 George Third, cap. 9, which allows the fitter previous to the commencement of the loading, to deliver in a certificate of the quantity which he intends to ship, which is the usual practice here, were repealed; and we are of opinion that the notice given agreeably to your Honor's general order of the 19th instant will serve as a salutary check upon coal fitters. We beg to observe that if any waggons have been altered after the weighing and marking thereof so as to be capable of carrying, a greater quantity of coals than they are marked to carry, as insinuated by the petitioners, we conceive the officers whose more immediate duty it is to inspect the waggons at the staiths, would seize the same under the Act 55th George Third, cap. 118. sec. 7.

On that part of the petitioners' statement wherein it is suggested to have the waggon restricted to carry precisely 53 cwt. with a level surface, we beg leave to observe that such a measure is in our opinion theoretical and not likely to lead to any practical good, and to add that it appears to us unreasonable that the proprietors of one colliery, who may from their locality labour under some disadvantages, should expect that all the other proprietors of collieries on this river should be compelled to have their waggons altered; but if even they were, we do not perceive how that is to prevent the fitters from shipping an excesss whatever regulations might be adopted, if so inclined, which is humbly submitted.

We are your Honors' most obedient Servants,

(Signed) CHAS. OGLE,
THOS. GIBSON.

Although this feeble document, is, perhaps, hardly worth commenting upon, I deem it right to advert to one or two points in it.

It was *not* sought by the petitioners (as stated) to have the legal standard of 53 cwt. altered; but to have it generally, and not partially, established.

The waggons were *not* weighed and marked "to the greatest quantity they were capable of containing," but their loadings, *only*, as they were found (by Mr. Liddell) to have been filled, according to the will of the colliery servants, were weighed and marked upon them.

All the waggons below bridge were of like dimensions, being made conformable to the Custom House gage, and examined, and branded, by the officers, with the Custom House mark, before they were allowed to be used—the waggons above bridge, not being cognizable by them at all. The waggons of Jarrow Colliery had been made by the spout standard; yet Mr. Liddell found their loadings to range between the two extremes of $56\frac{3}{4}$ cwt. and $72\frac{1}{16}$ cwt.

There was *no insinuation* in the petition that waggons had ever been altered (after being weighed and marked) to carry a greater quantity of coals; neither was Fawdon Colliery a solitary case of suffering—the grievance was equally applicable, in degree, to all the above bridge collieries; but the owners of Fawdon were, probably, most alive to the evil, from their recent change.

The report of the Collector and Comptroller had, evidently, no weight with the Commissioners, who wisely came to an opposite conclusion, complying fully with the object sought by the memorial.

A letter from the Secretary to the Treasury, to the owners of Fawdon Colliery, communicated the information, and the following is a copy of it.

Treasury Chambers, 14th July, 1820.

Gentlemen,

Having laid before the Lords Commissioners of His Majesty's Treasury, your memorial suggesting that the waggons used in carrying coals should be constructed so as to be filled to a level surface, I am commanded to acquaint you that my Lords concur therewith, and the Commissioners of Customs have directed a clause to be inserted into the new Commission about to be prepared for marking of keels and waggons used in the Rivers Tyne and Wear, which my Lords trust will remedy the grievance complained of.

I am Gentlemen, &c., &c.,

(Signed) R. LUSHINGTON,

To the Owners of Fawdon Colliery.

The new commission for the admeasurement of keels, waggons, &c., on the rivers Tyne and Wear, bearing date the 30th of August, 1820, contained the following regulations in reference to the foregoing subject of stroke measure.

"And whereas it has been represented to the Commissioners of our Customs that great irregularities have arisen in the shipment of coals by waggons, from the practice of heaping the coals considerably above the rim of the waggon; you are to take care that such practice be discontinued, and that in future all waggons, or other carriages, used in the immediate shipment of coals, be filled with a level surface, and weighed to the utmost content they are able to carry when filled."

"You are not to weigh, mark, or number, or allow of waggons or other carriages of different dimensions being used at one and the same place, but shall cause the length and breadth at top and bottom, and height upright, to be carefully taken; and on the dimensions of the several waggons at each colliery being found of an uniform size, you shall cause such waggons or other carriages to be fully loaden with a level surface at the pit, or other place of loading; and you shall proceed to weigh the coals at the staith, or most convenient place, and the weight thereof shall be marked on such waggon or other carriage, and deemed the utmost content which such waggon or other carriage is allowed to carry."

WEIGHTS AND MEASURES OF COAL.

On the 4th February, 1820, I procured the loan of a standard coal bushel measure from the Newcastle Custom House, and at the same time a stamped coal boll from Wallsend Colliery, which latter was the only one in the district that I could hear of. By careful measurement I obtained the following dimensions.

COAL BUSHEL.

Depth	$8\frac{1}{2}$	inches.
Mean of 4 diameters at top	$18\frac{6}{32}$	—
Ditto 4 ditto at bottom	$18\frac{9}{32}$	—
General mean diameter	$18\frac{1}{4}$	—

Content 2223·48 cubic inches.

COAL BOLL.

Depth	13	inches.
Mean diameter at top	$29\frac{5}{8}$	—
Mean diameter at bottom	$31\frac{3}{4}$	—
General mean diameter	$30\frac{11}{16}$	—

Content 9615·346 cubic inches.

CHALDRON WAGGON,

The following measurements are the mean lengths, breadths, and depths, for calculation, of a standard chaldron waggon.

Mean length of the hopper ... 5·895 feet		*Cubic Feet.*
Ditto breadth ditto ... ... 4·125 do.		Content 87·66233
Ditto depth ditto ... ... 3·605 do.		

Upon the bottom board, and below the top of the soles:

Length 2·75 feet, breadth 3·5 feet, depth 0·23 feet,

Less two battens 2·75 ft. by 0·83 ft. by 0·25 ft. cont. 1·92735

89·58968

	Cubic Feet.
Deductions from the hopper:	
The side and end cleading, curve inward 1¼ inch. The two bottom end angles are filled up to give a shooting slope to the opening for the bottom board,—these added together, are	6·89390
Content of the hopper, from the bottom board to the underside of the top rail.	82·69578
For the depth of the top rails:	
Length 7·5 ft. Breadth 5·25 ft. Depth 0.25 ft.	9·84375
The total content of the body of the chaldron waggon	92·53953
Consequently there remains to be heaped on the top, in cubical measure	31·79747
Which makes the full content (*vide* page 44) of a Newcastle chaldron	124·33700

Mr. Liddell (22nd March, 1819,) found that 3 upheaped standard coal bushels exactly filled a coal boll measure by the stroke. This, very nearly, but not perfectly, bore out my experiments on the same subject, which were as follows:

By the 12th of Anne—Stat. 2. and cap. 17, the coal bushel is to be made round, and to measure 19½ inches from outside to outside, and must contain 1 Winchester bushel and 1 quart of water.

	Cub. Inches
A Winchester bushel, or 8 gallons, each containing 268·8 cubic inches, make an aggregate content of	2150·4
And the solid content of one quart of water is ...	67·2
According to 12th of Anne the content of a coal bushel is	2217·6

THE HEAPED TOP.

	Cubic Feet.
A circular measure of coals (small) corn, &c., upheaped, will have a conical top, naturally formed, whose height will be two thirds its base. The base in this case is 19½ inches diameter, and the height of the cone, consequently, 13 inches; the content therefore is	970·58
The content of a bushel of coals is 1·845 cubic feet, or, in inches	3188·18

The content of the coal bushel, thus obtained, viz.. 3188·18 inches $\times$ 3=9564·54 inches, should have agreed with my measurement of the coal boll; but proving to be deficient by 50·8 inches, or $\frac{75\cdot59}{100\cdot}$ of a quart, the error is to be attributed to my method of adding the measurement of the heaped conical top to the content of the body of the bushel. The cubical measurement in inches of the coal bushel of the 12th of Anne, viz., 2217·6, must be admitted to be correct, because the calculation consists of figures founded upon unquestionable data, and are, therefore, incontestable. So much for the body of the measure, and next as to the heaped top, which, as there does not appear to be any definite mode of measuring, it remains for analogy to be resorted to. I assume my gage of the coal boll to be very nearly (and therefore adopt it as) the correct measurement, viz., 9615·346 cubic inches. If, therefore, the content of the stroke bushel be deducted from one third the boll, the remainder will necessarily give the measurement of the heaped top. Example, $9615{\cdot}346 \div 3 - 2217{\cdot}6 = 987{\cdot}515$ cubic inches, the solid measure of the top, which, consequently, makes the full cubical measure of the coal bushel ($987{\cdot}515 + 2217{\cdot}6 =$) 3205·115 inches.

The measurements of the Newcastle chaldron waggon of coals, the Newcastle coal boll, and the standard coal bushel, with their respective weights, having been set forth, I shall just give one example, in support of the views taken, and so fully explained, with respect to the heaped top, and the correctness of the weights and measures now laid down. On the 21st March, 1821, when the waggons of Fawdon Colliery had had tops affixed to them for the purpose of their carrying 53 cwt. by the stroke, I had one of the best of them (nearly new) selected for a trial, as to its content in weight, and measure. It was first gaged with the greatest possible minuteness, and proved to be of the capacity of 124·41 cubic feet. 53 cwt. of coals nicely weighed, were then shovelled in from a stage, and being carefully trimmed, were found to fill the body exactly level with the top of the ledges.* This experiment, it may be supposed, was highly satisfactory to me, as it proved the general accuracy of the various trials given, as also of almost innumerable others not given.

I was never able to make out anything like a satisfactory connexion of weights with the ancient Winchester measure of coals.

The 6th and 7th of William the 3rd, cap. 10, sections 2 and 3, establish the Newcastle chaldron of coals at 53 cwt.—the wains at 17½ cwt. and the carts at 8¾ cwt.—and that 3 wains, or 6 carts, are to be reckoned a chaldron, although these numbers bring out only 52½ cwt., as for the Newcastle chaldron.

The following extract, from Rees's Cyclopædia, furnishes a calculation based on the latter figure—it is given under the word "MEASURE."

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* Fawdon Colliery, at that time, delivered above bridge, and the addition of the tops, for stroke measure, was not a thing incumbent on the owners, but it was deemed advisable, in order to insure a uniformly correct chaldron of coals.

"The statute London chaldron is to consist of 36 bushels heaped up, each bushel to contain a Winchester bushel and one quart, and to be 19½ inches diameter externally—and as it has been found by repeated trials that 15 London Pool chaldrons are equal to 8 Newcastle chaldrons, if we reckon 52½ cwt. to the latter, we shall have 28 cwt. to the former, or 3136 lbs. to the London chaldron."

Why parliament made the Newcastle chaldron both 53 cwt. and 52½ cwt. does not appear, nor have I ever been able to obtain any information on a subject that seems to present so strange a contradiction; but as regarded coals shipped by waggons, it is perfectly clear, that 53 cwt. was the chaldron.

Dr. Hutton seems to have fallen into the same error as the Cyclopædia, as he found the above estimate nearly confirmed by experiment, for, weighing 1 peck of coals, he found it amounted to 21¾ lbs. and $4 \times 21\frac{3}{4} = 87$ lbs. for the weight of a bushel, and $36 \times 87 = 3132$ lbs. for the weight of the chaldron; to which, if the weight of the odd quart be added (3 lbs. nearly), we shall have 3135 lbs. for the weight of the chaldron, or only one pound less than that which is given by statute.

On the 10th of January, 1822,* my then partner, Mr. Charles Perkins of London, knowing that I had been at great pains to obtain information on this very unsatisfactory subject, caused to be weighed for me, with the utmost possible care, 12 sacks of coals, measured by the standard coal bushel, which were found to average 85lbs. and a small fraction to the bushel, being 2lbs. nearly, less than Dr. Hutton. But it is in vain to look for agreeing results where a

* Strange to say, that although I had some knowledge of almost every person in the North, at the period referred to—viz. 1812 to 1822—at all versed in the coal trade of the district, I never was able to fall in with any one who could give me the least valuable information on the subjects under discussion, and, indeed, I have reason to think they never had been fully investigated before.

heaped top is an element of the experiments, for, although it is in the power of the person up-heaping the bushel to make a great difference—less or more—in the amount of the cone, yet that person is utterly unable to fill always nearly alike, if he wished it—the extremely varying size of the coals themselves, also, rendering it a thing quite impossible in *that* point of view.

Having, after long research, and very numerous trials, arrived at certain conclusions regarding the weights and contents of the coal peck, bushel, and boll (although I must confess they do not perfectly satisfy me), I shall conclude this protracted article, by tabulating them, to suit the London, as well as the Newcastle coal measure.

THE LONDON COAL MEASURE.

Cub. Inches.	*lbs. Avoir.*	*Peck.*	*Bushel.*	*Sack.*	*Vat.*	*L.C.*
801·278	22·137	1				
3205·115	88·548	4	1			
9615·346	265·646	12	3	1		
28846·035	796·938	36	9	3	1	
115384·152 or 66·773 c. ft.	3187·752 or 28·462 cwt.	144	36	12	4	1

According to the above table, 8 Newcastle chaldrons make 14·89 of the London. But if the Newcastle chaldron is taken at 52½ cwt. then are 8 of the first mentioned exactly equal to 15 London, weighing precisely 28 cwt. and the bushel 87½ lbs. It appears, also, that the London sack, and the Newcastle boll, are just the same in measurement and weight—possibly the latter might be taken from the former?

THE NEWCASTLE COAL MEASURE.

Cub. Inches.	*lbs. Avoir.*	*Peck.*			
801·278	22·137	1	*Bushel.*		
3205·115	88·548	4	1	*Boll.*	
9615·346	265·646	12	3	1	*Chald.*
214854·906 or 124·337 *c. ft.*	5936.=53 *cwt.*	268·140	67·035	22·345	1

The measure of coals has ceased to be a subject of interest, in consequence of weight being substituted, both to, and from, the ship, as also in the London retail trade. The Act of Parliament which established the weighing system, was passed in October, 1831.

This salutary change from a system (at one period) fraught with endless frauds, and anomalous inconsistencies, to one yielding results of mathematical accuracy, may be said to have sprung out of the proceedings instituted by me, when a very near approximation to a truly defined measure (and weight) was effected in the substitution of the stroke for the heaped tops, which being analogous to the treatment of grain, cannot be far from the truth, if properly attended to.

This change from weight to measure, was followed by a corresponding alteration in the mode of ascertaining the pitmen's earnings weight being also adopted in the collieries instead of the old corf, or basket, measure—a change attended with beneficial effects, as thereby the interminable disputes (on that head) between the coal owners and their workmen were got rid of.

EXTRACTS FROM ACTS OF PARLIAMENT RELATING TO THE COAL TRADE.

6th and 7th, William the 3rd, Cap. 10.

Section 1.—Refers to the 9th of Henry the 5th and the 30th of Charles the 2nd, which have (it is stated) proved insufficient to prevent frauds. (It is worthy of being remarked, however, that the Act of Charles, just referred to, sec. 2, cap. 8, fixes the chaldron at 21 bolls heaped measure, each boll to contain 22 gallons and 1 pottle.)

Section 2.—Commissioners from time to time to be appointed for admeasuring and marking all keels, pan keels, pan boats, and other boats, and wains and carts used, or to be used, for the carrying of coals, allowing 53 cwt. to every chaldron.

Section 3.—The weight of coals in each wain to be 17½ cwt. and in each cart 8¾ cwt., and 3 such wains, or 6 such carts, shall be reckoned for one chaldron, such only as are employed in carrying coals from the staiths to be directly put into the ships, and no other shall be admeasured or marked.

Section 4.—The Commissioners appointed by His Majesty to admeasure keels, &c., to give three days notice of the time and place to the owners, and shall cause the keels and boats admeasured to be marked and nailed on each side of the stem and stern-post and midship thereof, or otherwise as they shall direct. The wains and carts to be marked and nailed on the heads and sides, or otherwise as they shall direct, by persons appointed and sworn before them for the true performance of this duty; and owners neglecting to have them measured after such notice, or using them in carrying coals before

being measured, to forfeit such keels with the coals on board them, unless the same shall happen from default of the Commissioners.

Section 5.—No such keel or boat to be measured, marked, or nailed, but between the 25th of March and the 29th of September, nor to carry more than 10 such chaldrons of coals at a time—at Newcastle, to be done at the New Quay, and those of Sunderland, to be admeasured at Lambton's Staith on the Wear, and not elsewhere. Keels and boats belonging Cullercoats, Seaton Sluice, Blyth Nook, and all other places in Northumberland and Durham; and also all wains, carts, &c., to be admeasured and marked at such times and places as the Commissioners shall deem fit.

Section 6.—If used previous to being measured, &c., to be forfeited together with the coals.

Section 7.—Marks removed or altered—offenders to forfeit £10—and keels, &c., as often as such offence shall be committed, to be re-admeasured, &c.

The 9th of Anne—Cap. 28.

Section 2.—Every fitter, vendor, or other person, shall sign and give to every ship-master, a true certificate, containing the day of the month and the year of such loading, the master's and ship's name, the exact quantity, and name of the colliery, and the price paid for each sort loaded on board—failure thereof, or granting a false certificate, offender to forfeit ten pounds.

Section 6.—Any ship-master whose vessel is loaded with coals only, to be delivered coastwise, may, upon producing his coast cocket and making oath of the true quantity of coals aboard his ship (such quantity not being less than expressed in the cocket) before the proper Officer of Customs, in any port in Great Britain, pay the

oversea duties for such coals, and shall receive a certificate of such payment in discharge of his coast-bond.

Section 8.—Every fitter, or other person, using keels, carts, wains, or other vessels not measured, gaged, and marked, according to law, in shipping coals on board ships, shall forfeit ten pounds.

The 12th of Anne—Stat. 2nd, Cap. 17.

Section 11.—The coal bushel shall be made round with a plain even bottom, and be 19½ inches from outside to outside, and contain one Winchester bushel and one quart of water—to be a heaped measure.

Section 12.—The standard bushel to be kept in the Exchequer.

The 1st of George the 1st, Stat. 2, Cap. 28.

Makes perpetual the Act of 9th of Anne—Cap. 28.

The 11th of George the 2nd, Cap. 15.

Section 8.—Commissioners appointed by the 6th and 7th William 3rd are authorised to admeasure, weigh, and mark all waggons, barrows and other carriages whatsoever used, or to be hereafter used, in loading ships with coals.

The 22nd of George the 2nd, Cap. 37.

Section 1.—Vessels having exported coals, culmn, or cinders, not to be cleared outwards, either coastwise or foreign, until a certificate is produced that the duties were fully paid for the last voyage—penalty on the officers one hundred pounds.

Section 2.—Limitation of action.

Section 3,—If a vessel clears coastwise and proceeds oversea, and delivers the coals, &c., or any part thereof, not being compelled by necessity to such proceeding, the master shall forfeit five shillings per chaldron for every chaldron so delivered, over and above the duties payable.

The 15th of George the 3rd Cap. 27.

Section 1.—Extends the Acts of the 6th and 7th of William the 3rd, to other ports in this kingdom from which coals are shipped. The regulations in this, and the following sections, place the practice on the same footing as at Newcastle and Sunderland.

Section 6.—Keels, &c., to be registered by the Collector and Comptroller, with the time and place of measuring, the dimensions, the names of the owners, and the quantity of coals which each keel, &c., will carry up to the mark thereon.

The 25th George 3rd, Cap. 54.

Repealed by the 52nd of George the 3rd, cap. 9.

The 31st of George the 3rd, Cap. 36.

Section 1.—No keel, pan keel, pan boat, or other boat, wain, or cart, used in the carriage of coals, that has been repaired, or altered, so as to carry a greater, or a less quantity, than on their first measurement, or having their rails, or marks removed, so that the loading cannot be ascertained in the usual way, whether by accident or otherwise, shall be again used until re-admeasured, on forfeiture of such keel, &c., &c., together with the coals found on board thereof.

Section 2.—Notice of repairs or alterations to be given to the Commissioners by the owners. The Commissioners, within 24 hours after receipt of such notice, shall give three days notice of the time and place for re-admeasurement.

Section 3.—If any marks are removed by accident, and without intention of fraud, after such keel, &c., has been fully loaden, to be permitted to discharge the same of its contents.

Section 4.—Persons wilfully removing or defacing marks put on keels, &c., shall forfeit a sum not exceeding five, nor less than two pounds.

THE 39TH OF GEORGE THE 3RD, CAP. 84.

Section 1.—The purchase by the Crown of the Duke of Richmond's duty made lawful.

THE 39TH AND 40TH OF GEORGE THE 3RD, CAP. 43.

Section 1.—The purchase of the Duke of Richmond's duty confirmed.

THE 45TH OF GEORGE THE 3RD, CAP. 128.

Permits the introduction of coals by canals, into London. Reference made thereto, also, in the 50th of George the 3rd, cap. 110, as well as in the 53rd of the same reign.—Cap. 135.

THE 52ND OF GEORGE THE 3RD, CAP. 9.

Section 1.—Repeals the 25th of George the 3rd, cap. 54. So far as relates to England and Wales.

Section 2.—No cocket to be granted for coals, culmn, or cinders, nor shall the master be permitted to load any, until the fitter, coal

owner, or his agent, delivers to the Collector, Comptroller, or other proper Officer, two certificates expressing the real quantity intended to be loaded, signed with his or their own hand or hands, which the collector will sign also, and register in a public book—one of which certificates to be returned to the master, and the other to remain in the custody of the Collector. All persons to have access thereto without fee, and no vessel to be cleared without such certificate.

Section 3.—Cockets to be granted on delivery of certificates.

Section 4.—Certificates to express the true quantity of coals, culmn, or cinders, to be exported beyond sea.

Section 5.—False certificates to subject fitters to one hundred pounds penalty.

Section 6.—Any vessel that clears coastwise, but delivers over-sea, to pay export duty on the greatest quantity of coals the ship can carry, and also three shillings per chaldron Winchester measure; but on proof before the Collector and Comptroller, by the master, mate, and two of the mariners, that the vessel was forced oversea by adverse winds, &c., and also admission thereof signified by the Commissioners of Customs, such three shillings per chaldron to be returned by special certificate, and the master's coast bond discharged.

Section 7.—Vessels to be admeasured at the port of return, to determine the greatest number of chaldrons (Winchester-measure) they can carry. The admeasurer to be paid one-penny-half-penny per chaldron.

Section 8.—The entry and registry of the certificates to be admitted as evidence.

Section 9.—The recovery of penalties.

Section 10.—General issue may be pleaded.

THE 55TH OF GEORGE THE 3RD, CAP. 118.

Section 7.—Keels, boats, waggons, &c., found to have a greater quantity of coals than by their marks they are allowed to carry, whether by weight or measure, coastwise or foreign, to be forfeited —one moiety to the Officer, and the other moiety to the King.

THE 56TH OF GEORGE THE 3RD, CAP. 127.

Section 1.—Coals that have passed through a riddle or skreen, the bars of which are not, in any part, more than three eights of an inch asunder, shall be charged with the same duty as culmn, on being exported oversea.

Section 2.—A certificate under the hand of the owner of the pit, or his known agent, shall be delivered to the Collector, specifying the real quantity of coals he has passed through such riddle or skreen, stamped as directed by this Act, and the name and residence of the owner of such coals, and a description of the situation of the mine from which they were raised.

Section 3.—Mine owners to provide riddles, or skreens, which shall be stamped as the Commissioners of Customs may direct. Coals of a larger size to be charged full duty.

Section 4.—Coals entered at the low duty, but which shall have passed through a riddle, or skreen of larger dimensions than is allowed by this Act, shall subject the owners to a penalty of £10 per Newcastle chaldron.

Section 5.—Officers to attend the skreening of the coals when practicable, and when unable to do so, may cause them to be re-skreened.

Sections 6 *and* 7.—Direct how the duties are to be levied and applied. The orders issued by the board under this Act, were as follow. 1816, July 19th, No. 337,—and September 26th of same year, No. 439, viz., that the law does *not* require the riddle or skreen to be retiform—1817, January 9th, No. 17, the skreens *must* be made retiform—1817, February 13th, No. 84, revokes the order of 9th ultimo, No. 17,—1817, February 27th, No. 118, Skreens, the bars of which are of cast-iron, may be used without having cross-bars—*i. e.* not reticulated.

REMARKS AS TO THE LOW DUTY ON SMALL COAL.

The reduction of duty on a certain description of small coals shipped oversea, which the last referred to Act provided for, originated in a conversation at one of the Wear Coal Trade Meetings, held at Chester-le-Street, in the year 1815, between Mr. Robinson (the then Collector of Customs at Sunderland), the late Mr. Thomas Croudace, and myself; when I suggested the increased exportation which would be likely to arise, should such a reduction be allowed; and the benefit which the coal-trade would gain by shipping off what was then destroyed—naming the width of the skreens between the bars, and the length which occurred to me as being proper for the purpose; and which were, in fact, the dimensions of the skreens then, and for some time before, in use at Ouston Colliery. The subject was afterwards generally discussed by the meeting, and the idea was decidedly thought well of; but $\frac{3}{8}$ of an inch for the width between the bars was considered too little; as well it might be, $\frac{1}{2}$ inch being the most common gage at that period, and even as wide

as $\frac{5}{8}$ by no means uncommon; but then it must be borne in mind that the screens were very short, and that a large portion of the coals passed down them, did not come in contact with the bars at all; which has been alluded to before under the head of Coal Skreens, page 20. Very soon after this, Mr. Robinson, and some others of the party, paid a visit to Ouston Colliery, and were satisfied in regard to the skreens. That gentleman opened the subject to the Commissioners of Customs, and a correspondence ensued, which ended in their recommending the matter to the Government, and a Bill was brought in, and passed into law, just before the death of George the Third.

ON THE WEIGHING OF KEELS,

AND THEIR BUOYANCY AT DIFFERENT STATES OF THE TIDES, AND AT DIFFERENT PLACES ON THE RIVER TYNE.

The Keel Commission requires that all keels, &c., on the River Tyne shall be weighed and marked at the (Newcastle) New Quay. At low water the river, at that place, is constituted of entirely fresh water; and at high water, even, the admixture of fresh and salt water, is such, as to make its buoyant property by no means so strong as during all states of tide at Shields.

I was aware that the floating power of the water in the Tyne varied materially with the different heights of tide; but no definite information, as far as I had been able to learn, had ever been obtained on the subject. I therefore determined to ascertain it, and having had experience of Mr. John Liddell's care and tact in experimenting on the weights and measures of coal, I deemed him a fit person to be entrusted with the undertaking; and he very readily

undertook it, and charged himself with the execution of the business personally; and the following minutes are transcribed from his notes:

"May 11th, 1820. High water at Newcastle (new) Quay at 4h. 12m. P.M.

"The weights were put into keel 316, to bring her down to the 8 chaldrons mark, and the keel was thus taken to Stella, which is the highest staith on the river."

"May 12th at ½ past 5, A. M., examined the keel at Stella, and found no visible difference in her swimming."

"At ½ past 3, P. M., (the same day) examined her at Fawdon Staith (Scotswood), and found, there also, no apparent difference."

"Proceeded with the keel down the river, and examined her carefully at Pelaw Staith, (Moody's Quay,) at 40 minutes past 6, P. M., when it took 4 cwt., additional to bring her down to the 8 chaldrons mark."

"At Russell's Wallsend Staith it took 1 cwt. more, and at Shields New Quay, where we arrived at 8, P. M., it required 12½ cwt. more to bring her to her proper marks, making, in all, 17½ cwt. At 11, P. M., (the same day, viz, 12th May,) again examined her, it being low water, and had to take out 7 cwt., to lift her to the 8 chaldrons mark; which made the difference between high water at Newcastle and low water at Shields 10½ cwt."

"May 13th, at 4, P. M., found that the keel had freed considerably during the flood tide, and that to bring her to the 8 chaldrons mark it now took 16½ cwt., additional to the 10½ cwt., (the excess of the floating power of Shields low water) which consequently determines the difference of high water at Newcastle New Quay and Shields New Quay, to be 27 cwt."

There resulted, from the above experiment, this satisfactory fact —that the New Quay at Newcastle is a very proper place for the Commissioners' operations, of weighing and marking; for, if the keels are put off at the staiths, above bridge, with their just loadings (conformable to the marks), they can never, at any stage of the tide, in any part of the river, be liable to seizure, for their marks, by being out of the water, may indicate a deficiency of weight, but never can show a surplus by being sunk below it.

The case of the spout keels, below bridge, is somewhat different —there may, at times, be a discrepancy between the real and apparent weights, prejudicial to the colliery owners; but as the loadings of such keels are determined by the waggons, there is little likelihood of any inconvenience arising to those parties.

WEIGHT OF COAL IN THE SOLID, AND IN THE BROKEN STATE.

Coal, in its natural bed, pretty strongly indurated by time and a heavy superincumbent covering, weighs 78·12 lbs. per cubic foot. The same coal in the broken, or wrought condition, as generally delivered into waggons, on the pit bank, over skreens, the width between the bars of which is $\frac{3}{8}$ of an inch, weighs about 47·87 lbs per cubic foot; or, the solid to the broken coal, as 100 : 61·27. The small coal produced by such skreening, passed over a $\frac{3}{16}$ of an inch skreen, weighs about 43·08 lbs per cubic foot, making the solid coal to the re-skreened small, as 100 : 55·14 ; and the $\frac{3}{8}$ skreened best coal, to the re-skreened small, as 100 : 90 ; which represents this latter description of small coal as one tenth lighter than the merchantable best coal; the trials which brought out the above figures being made chiefly on the Wear Hutton seam.

A seam of coal 1 inch thick contains, as it lies in the natural bed, 47·77 Newcastle chaldrons in an acre, being in weight 126 tons, 12 cwt.

A seam 1 foot in thickness contains 573·26 Newcastle chaldrons, or, 1519 tons 3 cwt. 0 qrs. 11 lbs.—And a seam of 1 yard thick contains 1719·79 Newcastle chaldrons, or, 4557 tons 9 cwt. 1 qr. 5 lbs.—The weight of a cubic yard in the natural bed being 18·83 cwt.

A summary method of calculating the quantity of coal in an acre, in the counties of Northumberland and Durham, is, to reduce the seam to cubic yards, and allow three of them to be a Newcastle chaldron. This is not quite correct, for if the computation be applied to a 3 feet seam, we have in an acre (4840 cubic yards ÷ 3

=) 1613·66 Newcastle chaldrons, which is 106·13 chaldrons less than the real quantity, or 6·17 per cent. below it. This, however, for practical purposes, is near enough, and makes the deviation on the proper side.

COAL AND COKE.

So important an off-shoot of the coal trade, has the business in coke become, in these northern counties, that it cannot be necessary to offer any excuse for devoting a little space to some observations relative to the connexion of coal and coke, and the comparative powers of the fuel in its twofold state.

The best coking coals of the Tyne, are upon the western verge of the Basin—indeed, the same peculiarity seems to prevail throughout the coal-field to its southern extremity. In the first portion, the six quarter, and the Brockwell seams, have yielded the Garesfield, and Wylam cokes; the first, being the property of the Marquis of Bute; and the latter, of Mr. Blackett. These, exclusively, as regards the North of England, possessed both the home and the export markets, for a long period of time; nor were they interfered with until within a few years back, when the demand for locomotive engines, as well as for abroad, became considerable. Other collieries, then, in the neighbourhood of those above adverted to; and some, more in the heart of the Basin, with coals not so well adapted; and many in Weardale (in the second of the above sections) with coal of excellent quality for the purpose; commenced coke burning; so that at the present time (May, 1847) the coke trade has risen up into one of considerable importance on the rivers Tyne, Wear, and Tees, with a flattering prospect for the future; as the demand,

even now, cannot be met, and new sources of requirement are springing up in the shape of railways and foreign markets.

Deduced from results of very extended operations, I am able of my own knowledge to state, that the six-quarter seam yielded 60 per cent. or something more; and the Brockwell about 53 per cent. A chaldron waggon of these cokes, of the Newcastle, or statute measure, weighed and taken with care, was found to be 26 cwt. 2 qrs. 8 lbs., averaging 24 lbs. to the cubic foot. The commercial (or imperial) chaldron of coke (commonly, but erroneously, called 12 bolls), is a moiety of this, viz., 13 cwt. 1 qr. 4 lbs.

There are some rather singular coincident circumstances connected with coal and coke, which I shall now consider.

In the making of coke, when the combustion is over—that is, when the gases are consumed — the waste ceases, however long afterwards the charred fuel remains in the oven, closed up, and secured against the access of air; during which, however, a great improvement is going on in the hardening and perfecting of the coke. The time requisite for the *burning* part of the process, varies with the bulk of the mass under treatment, as well as the nature of the coal itself. An oven charged (of course lightly) for a 24 hours carbonization (that is, charging, burning, and drawing, inclusive) will have ceased its combustion in about 17 or 18 hours—charged for a 48 hours operation, with a good deal heavier load, the combustion will be done in 30 or 32 hours. These short periods may be said to be for private use—at least in this part of the kingdom — as, when coke is designed for sale, and particularly for shipment, regard to its appearance is expedient, and with this view, much longer times for carbonizing are resorted to, as 72 and 96 hours, and occasionally even 120 hours; by which means, a more compact, hard, and silvery looking fuel, is obtained. In South

Wales, the furnace coals are less bituminous, contain more carbon, and are freer from sulphur. A shorter period for carbonizing is practised there, than has been found requisite here; 24 hours for the complete operation being the most approved time. It is proper to observe, however, that by far the largest proportion of coke, used in the Welsh blast furnaces, is made from large coal in open beds; such coke weighing from 31 to 32 lbs. the cubic foot.

In round numbers, it may be said, that coal yields half its weight, and an equal bulk, in coke — that the product (thus reduced in weight) possesses a heating power as great as the original fuel. These figures do not exactly represent the comparative capability and relations of the two conditions of the fuel; but, generally speaking, they sufficiently approximate for the present object. The quantum of heat thus wasted, by the burning of the gases, I am not prepared to state; but some idea may be formed of its importance when it is observed that a ton of good Newcastle coal, by the coking process, gives out from 10 to 12,000—say 11,000—cubic feet of carburetted hydrogen gas; about 10 gallons of tar; and about 18 gallons of ammoniacal liquor; all which products are absolutely destroyed. If the gas was valued, as for lighting purposes, at the low figure of 4s. per 1,000 cubic feet, it would amount to £2. 4s. 0d., giving the tar and ammoniacal liquor in; while the coke produced by a ton of coal, assuming 60 per cent. to be the yield, would be 12 cwt., and the worth, at 10s. per ton, 6s., which is less than one seventh of the value of the gaseous product now thrown away. What might be the value of the gas as a heating agent (as before remarked), I cannot definitely speak to; but I apprehend it will not be rating it too high to take it as equivalent to the coke. These facts are very striking and show a wide field spread out for the man of genius and science. For my

own part I cannot doubt the arrival of the day (how soon, or how late, is not to be foretold) when the entire products of coal will be secured and rendered available.

Having had no inconsiderable experience in coke making, both in South Wales by open burning in beds, and by oven burning in this district; and having also experimented with ovens of (I apprehend) every variety of size and shape, it may not be deemed irrelevant, perhaps, if I offer some opinions which have resulted from the practice referred to.

The ovens in most common use here, are of the circular kind, with dome tops. From this figure, I believe, I was the first to depart, by the adoption of the parallelogram form, being thereto induced by economical views solely, for the quadrangular oven assuredly saves considerably in the cost of construction—1. in the comparative expense of fire bricks; the one requiring bricks of a plain and ordinary size, while the other must have them specially made both as to shape and size; which brings them to treble the cost; 2. a group of round ovens renders necessary a greater quantity of materials in the filling up of the angular vacuities; and 3. the workmanship is more expensive. I have found the saving to vary between a quarter and a third. Then, as to their comparative merits, the idea may probably arise, that as the circular oven comprehends a more concentrated body of the material, the burning should be more uniform; but this does not appear to be the case. An impression is prevalent in this neighbourhood that the larger the body of coal employed, and the better is the resulting quality of the coke. This is undoubtedly true; but it is a benefit gained at no trifling cost, which may be explained as follows. The larger the mass and the longer is the time required to burn off the gases; for while 17 or 18 hours are needed for the combustion of a charge

adapted to a 24 hours operation, double that time will be necessary for one of a 72 hours process; and during the time of combustion, not only are the gases burnt off, but a quantity of carbon is also destroyed at the same time. Hence, the longer the time taken for burning the gases, and the greater is the waste of coke—a loss, on the whole, far from inconsiderable.

They find advantages in Wales by the short periods of carbonization, of a twofold nature, viz., the obtainment of a better yield, and the turning out of more work by the same means as to the number of ovens—the heat is kept up to a higher temperature by reason of these quickly repeated operations, and the short intervals of the burnings; which conduces greatly to the promotion of rapid and good results, both in respect of quantity, and the per centage yield. By the extended operations, as carried on here, the heat of the oven is greatly reduced, even before the drawing commences; and subsequently, the length of time necessary for the drawing, and again for the filling of so heavy a load as 9 or 10 tons (which not unfrequently happens), the temperature is, further, so very much lowered, that the ignition of so large a body of coal is slow, and the combustion very tardy; the light charges, on the contrary, going off at once, and that very vigorously.

It has often occurred to me that if an oven (suppose of 10 feet diameter) was charged for a 24 hours process, with 2½ tons of small coal (which would form a layer of some 2 feet in thickness) was re-charged upon the coke, so soon as the gases were consumed, viz., in 17 or 18 hours, with a fresh supply of coal some 18 or 20 inches thick (about 2 tons) that the high temperature of the oven, together with that of the coke itself, would be such as to complete the second burning, on Lord Dundonald's principle of distillation, stopping up all the openings for the ingress of air, and merely inserting a pipe

for passing off the gases. By these means *all* waste of carbon would be prevented in the second proceeding, and a much greater yield of coke could not fail to be gained. In case the power of heat was found insufficient to carry out the distilling process, a little air, more or less, as might be found necessary to aid the other means, could be admitted; but I am of opinion this would not be called for —a higher doorway might probably be required.

COLLIERY STORE-KEEPING.

There are few (secondary) matters coming into the department of colliery management, more worthy of economical attention, than the serving out of stores, by which I mean whale-oil, grease, tallow, nails, candles (particularly), and all other lesser things properly embraced in the category; and yet, I believe, it was in general a thing very little regarded, for I never could find out that, at the period I allude to, viz. thirty-six years back, any clear and fully recorded account was kept of the dispensing of stores at any one colliery in Northumberland or Durham.

I bestowed some time in the consideration of this subject, and after various arrangements and trials, at length, in the year 1815, brought into use the following system.

The individual filling the post of store-keeper, was necessarily required, from his multifarious duties, not only to write a good free hand, and be a ready arithmetician, but to be a person of some intelligence also. The store-house and office were contrived to be conveniently situated, with reference to the joiners' and blacksmiths' shops, the corn lofts and stables. His charge was made to comprehend

a considerably more extensive service than the mere receipt and distribution of the stores, and, in fact, it became a weighty and important office. Besides receiving in, and delivering out, the stores, and keeping a journal and ledger, to show sectionally (by double entry) their distribution; he had to check the accounts of all tradesmen's invoices, and enter them—to keep a time and task account of joiners, blacksmiths, waggon way wrights, breaksmen and labourers; having reported to him, fortnightly, by the different overlookers, such information as lay too distant for his supervision—added to which, he was required to make out the fortnightly pay bills, and keep a daily account of the pit bank operations with the averages; which will be noticed by and bye. But the *pro forma* statement, or journal entry, for a single fortnight, or pay, given on the two succeeding pages, will better explain the nature and extent of the store-keeper's employment.

The delivery of coals, at the pit, is not noticed in the account, for the reason that it would only have loaded it unnecessarily; the staithman's return of shipments being the book-keeper's guide and authority; and the "Pit Bank Daily Receipt and Delivery" its check. The statement generally, it is presumed, will sufficiently explain itself, though it may be as well to remark that the only double entries are the accounts entitled—candles, whale oil, grease, tallow, and nails. The second column contains the posting figures by which these accounts are respectively debited, and at the bottom of the columns so headed, are the posting figures by which they are credited.

VICTORIA COLLIERY.

STORE-KEEPER'S JOURNAL.—RECEIVED AND DELIVERED.

1815.	L. Fo.	No. 16 Pay, ending with the 22nd August.	Candles.	Whale Oil.			Greas.	Tallow	Nails.
			lbs.	Gal.	Qt.	Pint	lbs.	lbs.	lbs.
			10¾d.	2/10	8½d.	4½d.	6d.	8d.	5d.
Aug. 9	145	Dr. Adelaide Plane Engine, ⅌ J. Clark, for a Tin Case 1s. 6d. and	..	1	..	..	..	14	..
..	155	.. Wrights and B. Smiths a/. for 3 Stock Locks 8s. and	..	..	..	..	..	..	25
..	190	.. *Horse accot. to M. D. Scott, for 12 Thrave Straw* £1 10s. 0d.							
Aug. 10	155	.. Wrights and B. Smiths, ⅌ C. Cox, for a File, 10d. and	..	..	1	..	..	..	..
..	170	.. Wag. Way a/. ⅌. G. Thomas, for Alice Plane Break	..	..	..	..	..	..	14
..	135	.. Alfred Plane Eng. for 2 yds. Flan. 2/3, 2 lbs. paint 11d. and	1	..	..	..	..	..	..
..	115	.. Albert Pit Pumping Eng. 2¼ lbs. Leather 7/10, and	1	..	1	..	10	20	..
..	85	.. *Nails a/. to S. Worthy* 168 *lbs. Joiners'* 12*d. Nails* £2 16s. 0d.							
Aug. 11	105	.. Albert Pit a/. for 2 yds. Flanl. 2/3, 2 Shovels 3/0, and	6	..	..	..	56	..	60
..	190	.. Horse a/. ⅌. J. Graham, 2 Shoulder Pads 2/0, and	4	..	..	1	..	..	..
..	170	.. Wag. Way a/. ⅌ G. Thomas, for 2 Spades 8/0, and	..	..	..	..	56	..	34
..	105	.. Albert Pit a/. ⅌ C. Monk, for repairing the Shaft	3	..	..	..	..	..	30
..	125	.. Albert Pit Drawing Eng. 10 lbs. Hemp 7/6 and	2	1	..	..	..	10	..
..	170	.. Wag. Way a/. ⅌ F. West	..	..	..	..	56	..	10
Aug. 12	105	.. Albert Pit a/. ⅌ C. North	..	15	..	..	..	..	20
..	135	.. Alfred Plane Eng. ⅌ G. Thomas, 5 lbs. Hemp 3/9, and	1	..	..	..	..	14	..
..	205	*Cr. J. & R. Davis for* 1 *cwt. Hemp* .. £4 4 0; .. *Pr. Flat Pit Ropes* 18*c.* 1*q.* 14*lb*... 64 2 0; .. *Ro. Rope for Alice Plane* 675 *fms.,* 6 *inches girt, weight* 2 *ton* 17 *cwt.* 2 *qr.* @ 44/ 126 10 0 — £194 16 0							
..	285	.. *Alcock & Co.* 138 *7ft. Memel Deals,* 3 *inches,* 6½d. .. £25 3 1½							
Aug. 14	155	Dr. Wrights and Smiths a/. 2 Thumb Latches and 4 pr. T. Bands 3/6, and	6	..	1	..	..	..	16
..	105	.. Albert Pit a/. for 1 Shovel 1/6, 1lb. Hemp 9d., and	1	..	..	..	56	..	30
..	155	.. Wrights and Smiths a/. ⅌. C. Cox, 2 Files 2/8, Screws 1/6, and	1	..	..	1	5	..	13
..	205	*Cr. Sundries a/. sold G. Gordon, Wag. Horse, Ball,* 11 *yrs. old* £20 0 0							
..	220	*Dr. Hay a/. to Jones and Co., for* 20 *tons old Hay,* 6/0,.. £120 0 0							
..	190	.. *Horse a/. to M. D. Scott for* 12 *Thrave Straw* £1 10 0							
..	235	.. *Horse Corn a/. to Dixon & Co. for* 50 *Qrs. Oats,* 18/0 .. £45 0 0; 50 *do. do.* 20/0 .. 50 0 0; 20 *do. Beans* 32/0 .. 32 0 0; £127 0 0							
Aug. 15	105	Dr. Albert Pit a/. ⅌ G. Thomas, 1 Stock Lock 2/0, 1 Pad Lock 1/0, and	2	..	..	..	..	..	40
..	170	.. Wag. Way a/. ⅌ D. Ross, a Spade 4/0 and	..	..	..	..	..	..	20
..	205	*Cr. Sundries a/. sold T. Robson, Horses, Capt. and Bob* .. £19 0 0							
..	205	*Dr. Sundries a/. to Martin & Co. for* 2 *doz.* 14 *in. Files* .. £1 13 0; 1 *doz. do.* ½ *round do.* 0 16 6; 1 *doz.* 12 *in. round* .. 0 11 6							
		Stores carried forward .. £3 1 0	[illegible]			..	239	58	312

VICTORIA COLLIERY

STORE-KEEPER'S JOURNAL.—RECEIVED AND DELIVERED.

1815.	L. Fo.	No. 16 Pay, ending with the 22nd August.	Candles.	Whale Oil.			Greas.	Tallow	Nails.
			lbs.	Gal.	Qt.	Pint	lbs.	lbs.	lbs.
			10¾d.	2/10	8½d.	4¼d.	6d.	8d.	5d.
Aug. 16		Amount of Candles, Whale Oil, Grease, Tallow, and Nails, brought up	28	18	..	..	239	58	312
..	190	Dr. Horse a/. ⅌ J. Graham, for a Broom 5d. and	4	..	..	1	..	..	..
..	85	.. *Nails a/. to S. Worthy, 840 lbs. assorted Nails* £14 0 0							
..	155	.. Wrights and Smiths a/. 2 14 in. Flat, 1 Half-round, 1 round File 5/3	1	..	1	..	..	..	10
Aug. 17	105	.. Albert Pit a/. 4 lbs. Spun Yarn 2/2, 1 yard Flannel 2/0, and	1	..	..	..	..	..	..
..	5	.. *Candles a/. to Turner & Co., 20 doz. 16 Dips 10/6* .. £10 10 0							
..	45	.. *Grease a/. to ditto, 20 firkins Grease* 26 0 0							
..	65	.. *Tallow a/. to ditto, 9 cwt. Russ. Tallow* 29 14 0							
..	25	.. *Whale Oil a/. to ditto, 1 tun W. Oil* 40 0 0							
		£106 4 0							
..	155	.. Wrights and Smiths a/. 2 Snecks and Handles 1/4, 2 S. Locks 5/4, and	..	..	..	..	..	..	10
..	170	.. Wag. Way a/. ⅌ F. West	..	..	..	..	56	..	20
Aug. 18	105	.. Albert Pit a/. ⅌ C. North	..	15	..	..	28	..	15
..	125	.. Albert Pit Drawing Engine, 6 lbs. S. Yarn 3/3, and	1	..	..	1	..	5	..
..	250	.. *Cast Iron a/. to Jenkins & Co. for 45 cwt. Tram Plate* .. £38 0 0							
..	250	*Cr. Cast Iron a/. sold ditto 1 ton old Metal* £5 0 0							
Aug. 19	190	Dr. Horse a/. ⅌ J. Graham, 5 yds. Flannel 11/3, and	1	..	..	1	..	..	..
..	170	.. Wag. Way a/ ⅌ F. West	2	..	..	..	..	..	..
..	265	.. *Bar Iron a/. to Bell & Co.,* *5 cwt. common Iron* .. £5 10 0 *3 cwt. assorted Bolts* .. 3 18 0 *3 cwt. Boiler Plates* .. 6 18 0 *4 cwt. assorted Squares* .. 4 16 0 £21 2 0							
Aug. 21	115	Dr. Albert Pit Pumping Engine, 5 lbs. Leather 15/8, and	2	1	..	..	14	56	..
..	155	.. Wrights and Smiths a/. 2 S. Locks 5/4, 2 Pots and 2 Ovens 22/0	1	..	..	1	..	..	20
..	285	.. *Timber a/. to Ward & Co. for* *150 ft. Scotch Fir* .. .. £9 7 6 *And 600 ft. U. Firs 6d. ⅌ 6 ft.* 2 10 0 £11 17 6							
Aug. 22	170	.. Wag. Way a/. ⅌ F. Johnson	..	..	..	..	56	..	10
..	190	.. Horse a/., 2 Curry Combs, 2 Brushes, 2 Combs 8/0, and	1	..	..	1	..	..	..
..	115	.. Albert Pit Pumping Engine, 4 lbs. Spun Yarn 2/6, and	1	1	..	..	..	..	..
..	155	.. Wrights and Smiths a., 2 Flat 14 inch Files 2/10							
..	300	*Landsale Coals disposed of in the Fortnight.* *110 fothers Small for ready money 1/6* .. .. £8 5 0 *20 fothers Unscreened for ready money 4/0* .. 4 0 0 *3 fothers Unscreened to G. Tomlinson on credit 4/0* 0 12 0 *6 fothers Unscreened to C. Smith on credit 4/0* .. 1 4 0 £14 1 0							
		Totals of Candles, Oil, Grease, Tallow, and and Nails, delivered out	43	35	3	1	393	119	397
		Posted to the respective Accounts (Credits) in the Ledger Fo.	5		25		45	65	85

THE FOREGOING STATEMENT EXPLAINED.

The whole of the entries are not subjected to the double entry process, but those only which admit readily of a sectional division, viz., candles, whale oil, grease, tallow, and nails; which five heads constitute the material portion of the store department; all other deliveries are either passed to the respective accounts for which they were furnished, or, in case of there being none such suitable for the purpose, they are placed to "Sundries Account" as a general recipient for all charges that have not express heads to which they may be applicable; which account can be easily run through at the end of the year, and any particular list, or lists of charges, abstracted. Thus, everything supplied from the Store, is put down and carried to some account or other; and the collective, and entire charge of each, is separately exhibited in the ledger at the end of every year. The practical object, and the beneficial tendency, of this proceeding is, the ready means that the system supplies of comparing and, consequently, of checking the consumption—pay by pay—month by month—or yearly. Of the importance of some such control, no one, at all versed in colliery management, can help being sensible, for, where direct supervision is impracticable (as in this instance) and the things intrusted are valuable, as well as privately useful, (to say nothing of heedless waste) it is not to be expected but that a mal-application will take place. Malleable and cast iron are received into the smiths' shops, and the wright's yard, as are corn and hay into their respective lofts. These, with timber, and many other things, are only noticed by the store-keeper by way of recording their receipt on the colliery, for the book-keeper's information, being at the same time checked by him. It has been an old practice throughout the trade to keep

corn books, showing the quantity fortnightly bought in and delivered out, with the number of horses; I adopted a similar practice with respect to hay, trussing and weighing the whole out.

At the end of the year the stock of stores is accurately taken, the accounts balanced, and the actually resting quantities carried respectively forward for the commencement of new accounts—any little error, or difference, being written off to an account of "Gain and Loss." The entries in italics are copies of invoices, &c., which are sent to the book-keeper at the fitting office, fortnightly.

It will thus be seen that full and clear records are kept, by these arrangements, of everything received upon the colliery; and that they are, also, fully and clearly accounted for. The whole proceeding, indeed, is not more calculated to afford satisfactory information to the owner, than it is to hold a salutary check over waste and mis-appropriation.

Over the leaf is given a single illustrative account, for one year, taken from the ledger, with a summary, which will show how amply the expense, under each individual head, is set forth. All other accounts should be made up yearly in the same manner, and averaged to the score of twenty-one twenty-peck corves on the year's drawings, when the opportunity will be furnished of comparing and, consequently, of checking such accounts with each other.

ADELAIDE PLANE ENGINE.

1815	J. Fo.	Detail.	Candles. lbs.	Whale Oil.			Greas. lbs.	Tallow lbs.	Nails. lbs
				Gal.	Q.	Pint			
			10¾d.	2/10	8½d.	4¼d.	6d.	8d.	5d.
Jan. 8	34	Received 22 lbs. Spun Yarn	..	..	..	..	..	14	..
.. 18	36	.. 6 lbs. Paint, 7 lbs. Wire Rope ..	..	1	..	..	..	14	..
Feb. 10	40	.. ..	¼	1	..	..	..	..	..
.. 13	43	.. 1½ lb. Leather..	..	1	..	..	..	..	..
Mar. 8	51	.. 3 lbs. Spun Yarn	..	1	..	..	..	14	..
Apr. 2	62	.. 19 lbs. Hemp	..	1	..	..	..	14	..
.. 22	65	.. 1 Broom, 5d.							
.. 27	67	.. 7 lbs. Paint	..	1	..	..	..	15	..
May 7	69	.. 5 lbs. Paint	2	..	..	..	..	..	..
.. 17	71	.. 1 lb. Leather, 8 lbs. Spun Yarn							
.. 20	72	.. 8 lbs. Paint	..	1	..	..	..	..	..
.. 24	73	.. ..	..	..	..	..	..	14	..
June 9	77	.. ..	..	1	..	..	..	..	..
.. 24	80	.. ..	..	1	..	..	..	14	..
July 20	86	.. ..	..	1	..	..	..	14	5
Aug. 9	90	.. 5 lbs. Paint, 1 Tin Can, 1s. 6d.							
.. 13	91	.. 1 lb. Leather							
.. 17	92	.. ..	..	1	..	..	..	14	..
.. 24	93	.. 9 lbs. Wire Rope							
Sep. 2	96	.. ½ lb. Leather	..	1	..	..	..	14	..
.. 21	99	.. 7 lbs. Paint							
.. 25	101	.. ½ Yard Flannel 1s. 2 lbs. Paint							
Oct. 4	102	.. ..	¼	1	..	..	..	14	..
.. 21	106	.. ..	..	1	..	..	..	..	..
Nov. 1	108	.. 1 Shovel 5s. 3 lbs. Spun Yarn							
.. 5	109	.. 1 lb Leather	..	1	..	..	..	14	4
.. 15	111	.. ½ lb Leather							
.. 24	114	.. 7 lbs. Paint							
Dec. 6	117	.. 1 lb. Leather	..	1	..	..	..	14	0
.. 15	120	.. ½ lb. Leather							
.. 20	121	.. ..	..	1	..	..	..	..	..
		Account of Candles, Oil, Tallow, and Nails ..	2½	17	..	..	..	183	9

Summary Abstract of the above Account.

	£	s.	d.
2½ lbs. Leather @ 10¾d.	0	2	3
17 Gallons of Whale Oil at 2/10	2	8	2
183 lbs. of Russia Tallow @ 8d.	6	2	0
9 lbs. of Nails @ 5d.	0	3	9
7 lbs. of Leather	1	1	6
19 lbs. of Hemp @ 9d.	0	14	3
16 lbs. of White Rope @ 10d.	0	13	4
36 lbs. of White Spun Yarn	1	8	0
3 lbs. of Ditto Ditto @ 61/0	0	1	8
47 lbs. of Paint	0	18	7½
1 Tin Can	0	1	6
½ yard of Flannel	0	1	0
1 Shovel @ 5/0 and 1 Broom at 5d.	0	5	5
1 Year's total Amount .. .. .. £	14	1	5½

18,424 Scores of 20 Peck Corves, 21 to the xx., average $\frac{18}{100}$ of a Penny per Score.

PIT BANK DAILY RECEIPT AND DELIVERY.

The following tabular statement, being a fortnight's account of the daily receipt from the pit in corves, and the coals sent away in waggons, was another of the duties which the store-keeper was charged with. I brought this, however, into use, before the foregoing system of store-keeping was in full operation. It has been adopted at many collieries, but the great bulk of the trade, I believe, are either unacquainted with, or do not practise it. The plan will be found to be satisfactory and serviceable, in as much as that the loss by small passed through the skreens, is seen daily; and will frequently be the means of an excessive waste being curtailed. For, in the absence of such returns, viz., of the average number of corves necessary to make a chaldron (not yearly, or fornightly even, but daily); the fact of an exorbitant expenditure to produce one waggon with another, has sometimes come upon the owners like a thunder bolt—I have known some such instances myself, and I have reason to believe that they have not been of rare occurrence. Had the information which the table gives, been known, the waste, most likely, would have been promptly reduced.

It has been but too common a mistake to rest satisfied by witnessing the experiment upon a single waggon, made probably about, or after, the middle of the day, when the *curvings* and *nickings* have been mostly brought out of the pit, and the *round* coals are coming away. Any trial made at such a time is perfectly deceptive. The true and infallible course is, to divide the number of corves or tubs, drawn in the year, by the waggons of coal sent away from the colliery: this cannot err, and it would be advisable to check, even, the sum total of the annexed fortnightly returns, by such a test.

VICTORIA COLLIERY—ALBERT PIT—BANK RECEIPT AND DELIVERY.

RECEIVED. No. 16 PAY. ENDING WITH THE 22ND OF AUGUST 1815. **DELIVERED.**

Days of the Week.	Resting in the Morning.			Drawn ℔ 20 P. Cor.		Taken from the Heap.			Total Receipt to be Accounted for.			Wagg. sent away.	Put to the Heap.		Resting in the Evening.			Total Delivery.			Wagg. Small sent off.	Ave. Cor. to the Waggon.
	w.	xx.	cor.	xx.	cor.	w.	xx.	cor.	w.	xx.	cor.		xx.	cor.	w.	xx.	cor.	w.	xx.	cor.		
Wednesday	1	..	..	59	16	..	..	..	1	59	16	88	..	3	5	..	..	93	..	3	4	13.60
Thursday	5	..	..	61	14	..	..	..	5	61	14	95	..	1	6	..	..	101	..	1	9	13.48
Friday	6	..	..	62	..	..	..	..	6	62	..	98	..	1	4	..	..	102	..	1	22	13.55
Saturday	4	..	..	..	..	..	..	..	4	..	..	..	..	..	4	..	..	4	..	..	..	....
Monday	4	..	..	61	19	..	..	..	4	61	19	94	..	1	5	..	..	99	..	1	22	13.67
Tuesday	5	..	..	60	9	..	..	..	5	60	9	94	..	2	4	..	..	98	..	2	26	13.62
Wednesday	4	..	..	65	4	..	..	..	4	65	4	101	..	1	3	..	..	104	..	1	27	13.68
Thursday	3	..	..	65	16	5	..	..	3	65	16	102	3	10	1	..	..	103	3	10	22	13.76
Friday	1	..	..	68	11	..	..	..	1	68	11	91	..	13	13	..	..	104	..	13	25	13.84
Saturday	13	..	..	65	13	1	..	..	14	65	13	104	..	5	9	..	..	113	..	5	24	13.86
Monday	9	..	..	68	18	..	..	..	9	68	18	102	..	2	11	..	..	113	..	2	22	13.88
Tuesday	11	..	..	67	13	..	..	..	11	67	13	104	..	3	11	..	..	115	..	3	24	13.62
TOTALS	66	..	..	707	7	6	..	..	72	707	7	1073	5	0	76	..	..	1149	5	0	227	13.69

THE TABLE EXPLAINED.

The headings of the columns will be found sufficiently illustrative in themselves. The mode by which the number of corves taken for a chaldron waggon, is obtained thus:—To the quantity drawn up the shaft, add the resting morning waggons and corves, as well as what have been taken from the heap, in waggons and corves also (the operation, whether for a day, or the whole fortnight, being the same; the example adduced embracing the whole statement), divide this amount by the waggons sent away, together with the coals put to the heap and resting, viz., 66 waggons the mornings' restings + 707 xx. 7 c. + 6 waggons taken from the heap = 72 w. 707 xx. 7 c. the total recceipt; and per contra, 1,073 waggons sent off + 5 xx. put to the heap + 76 waggons evenings' restings =1,149 waggons and 5 xx. the total delivery.

These two sums, constitute the divisor and dividend, by which to work the question; but to obviate the increased trouble arising from mixed figures, the following simplified method may be adopted.

From 1,149 waggons — (66 + 6 =) 72 = 1,077 waggons for the divisor; and from 707 xx. 7 c. — 5 xx. = 702 xx. 7 c. for the dividend.

Then 702 xx. 7 c. × 21 = 14,749 corves ÷ 1,077 waggons = 13·69 corves, and decimal parts, taken to the chaldron waggon on the average for the pay.

The column of small sent off, is a mere record of its delivery, and has no reference to the general object of the table.

A TABLE SHEWING THE POWERS OF STEAM ENGINES ON BOULTON AND WATT'S CONDENSING PRINCIPLE, SUITED TO THE DRAWING OF COALS, AT SPEEDS FROM 4 TO 14 FEET PER SECOND, IN CORVES FROM 12 TO 24 PECKS (MADE IN THE YEAR 1813.)

Sizes of Corves and the Weights of their Contents.	4 ft. ℔ Sec.		5 ft. ℔ Sec.		6 ft. ℔ Sec.		7 ft. ℔ Sec.		8 ft. ℔ Sec.		9 ft. ℔ Sec.		10 ft. ℔ Sec.		11 ft. ℔ Sec.		12 ft. ℔ Sec.		13 ft. ℔ Sec.		14 ft. ℔ Sec.	
	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.	Horses Power.	Diamr. of Cylndr.
lbs.		*In.*		*In.*		*In.*		*In.*		*In.*		*In.*		*In.*		*In.*		*In.*		*In.*		*In.*
12 Pecks, 370.99	4.04	10.65	5.05	11.90	6.07	13.05	7.08	14.05	8.09	15.00	9.10	16.00	10.11	16.84	11.12	17.60	12.14	18.44	13.15	19.20	14.16	19.90
14 Pecks, 432.82	4.72	11.50	5.90	12.85	7.08	14.05	8.26	15.20	9.44	16.25	10.62	17.25	11.80	18.15	12.98	19.05	14.16	19.90	15.34	20.75	16.52	21.53
16 Pecks, 494.66	5.39	12.24	6.74	13.70	8.09	15.00	9.44	16.25	10.79	17.40	12.14	18.44	13.49	19.44	14.83	20.40	16.18	21.23	17.53	22.09	18.88	23.00
18 Pecks, 556.49	6.07	13.05	7.58	14.55	9.10	16.00	10.62	17.25	12.14	18.44	13.65	19.55	15.17	20.60	16.69	21.60	18.21	22.60	19.73	23,50	21.24	24.40
20 Pecks, 618.32	6.74	13.70	8.44	15.35	10.11	16.84	11.80	18.15	13.49	19.44	15.17	20.60	16.86	21.78	18.54	22.78	20.23	23.80	21.92	24.80	23.60	25.70
22 Pecks, 680.15	7.41	14.40	9.27	16.12	11.12	17.60	12.98	19.05	14.83	20.40	16.69	21.60	18.54	22.78	20.40	23 90	22.25	25.00	24.11	26.00	25.96	26.95
24 Pecks, 741.98	8.09	15.00	10.11	16.84	12.14	18.44	14.16	19.90	16.18	21.23	18.21	22.60	20.23	23.80	22.25	25.00	24.28	26.05	26.30	27.07	28.33	28.15

The above calculations are based on the following data—with reference to the corves, that the statute Newcastle chaldron weighed 53 cwt., and measured n solid content 134·4 cubic feet, and was called 24 bolls—the coal peck 1209·6 cubic inches, and weight 30·91 lbs. This latter weight, and the bulk of he chaldron, differ materially from the results obtained at a subsequent period, which have been very fully stated; but they were derived from the best nformation I was able to possess myself of at the time, and although erroneous, it makes the table the safer to rely upon, the peck being taken at more than its actual weight.

The engine power is formed on Dr. Robison's rule, who says (on the authority of Mr. Watt) that "a horse travelling 2½ miles an hour, raises a weight of 150 lbs. by a rope passing over a pulley, which is equal to raising 33,000 lbs. 1 foot high in a minute." The movement of the piston is taken at 2½ feet per second, and the power netted 10 lbs. per square inch of the piston, less one third for friction, imperfections, &c. The above table, though not strictly correct, may be taken as a pretty near approximation to the truth, and as furnishing information which there will be no danger in following.

CONVERSION OF MEASURE INTO WEIGHT.

The substitution of weight, for the measure of coals, both at the colliery loading ports, and those of delivery, was passed into law in October, 1831. The waggon heretofore in use, carrying 53 cwt. by a level, or stroke top, continued still to be the carriage employed, without any change. The colliery accounts, also, were still kept in chaldrons; and the staithman's certificates of loadings being filled up, as before, in chaldrons; it became a work of some trouble, to the fitter, as well as one liable to miscalculations, to convert such figures into tons and cwts., which he was compelled to resort to in his dealings with the ships.

The accounts at the coal trade office were kept in tons, after the chaldron measure was abolished by law; and the same practice was followed at the fitting offices; for the purpose therefore of saving labour and securing accuracy, as well as to afford some facility in the money calculations, I made out the following tables, viz., the conversion of the Newcastle chaldrons—1 to 150—into weight, and the relative prices of coals into measure and weight. To these I added the conversion, also, of the London chaldron into weight, beginning with 1 chaldron and running up to 300, a table now, however, of more than questionable utility, although, when compiled, it served a useful purpose of comparison.

The coal trade printed, and freely distributed, those tables; and they were afterwards embodied with others and published by Mr. Harrison.

THE NEWCASTLE STATUTE COAL MEASURE CONVERTED INTO WEIGHT.

Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.
1	2	13	23	60	19	45	119	5	67	177	11	88	233	4	109	288	17	130	344	10
2	5	6	24	63	12	46	121	18	68	180	4	89	235	17	110	291	10	131	347	3
3	7	19	25	66	5	47	124	11	69	182	17	90	238	10	111	294	3	132	349	16
4	10	12	26	68	18	48	127	4	70	185	10	91	241	3	112	296	16	133	352	9
5	13	5	27	71	11	49	129	17	71	188	3	92	243	16	113	299	9	134	355	2
6	15	18	28	74	4	50	132	10	72	190	16	93	246	9	114	302	2	135	357	15
7	18	11	29	76	17	51	135	3	73	193	9	94	249	2	115	304	15	136	360	8
8	21	4	30	79	10	52	137	16	74	196	2	95	251	15	116	307	8	137	363	1
9	23	17	31	82	3	53	140	9	75	198	15	96	254	8	117	310	1	138	365	14
10	26	10	32	84	16	54	143	2	76	201	8	97	257	1	118	312	14	139	368	7
11	29	3	33	87	9	55	145	15	77	204	1	98	259	14	119	315	7	140	371	0
12	31	16	34	90	2	56	148	8	78	206	14	99	262	7	120	318	0	141	373	13
13	34	9	35	92	15	57	151	1	79	209	7	100	265	0	121	320	13	142	376	6
14	37	2	36	95	8	58	153	14	80	212	0	101	267	13	122	323	6	143	378	19
15	39	15	37	98	1	59	156	7	81	214	13	102	270	6	123	325	19	144	381	12
16	42	8	38	100	14	60	159	0	82	217	6	103	272	19	124	328	12	145	384	5
17	45	1	39	103	7	61	161	13	83	219	19	104	275	12	125	331	5	146	386	18
18	47	14	40	106	0	62	164	6	84	222	12	105	278	5	126	333	18	147	389	11
19	50	7	41	108	13	63	166	19	85	225	5	106	280	18	127	336	11	148	392	4
20	53	0	42	111	6	64	169	12	86	227	18	107	283	11	128	339	4	149	394	17
21	55	13	43	113	19	65	172	5	87	230	11	108	286	4	129	341	17	150	397	10
22	58	6	44	116	12	66	174	18												

RELATIVE PRICES OF COALS.

THE TON 20 CWT.—THE IMPERIAL CHALDRON 25½ CWT.—THE NEWCASTLE CHALDRON 53 CWT.

℔ Ton.	℔ Imperial Chaldron.	℔ Newcastle Chaldron.	℔ Ton.	℔ Imperial Chaldron.	℔ Newcastle Chaldron.	℔ Ton.	℔ Imperial Chaldron.	℔ Newcastle Chaldron.	℔ Ton.	℔ Imperial Chaldron.	℔ Newcastle Chaldron.	℔ Ton.	℔ Imperial Chaldron.	℔ Newcastle Chaldron.
s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1 0	1 3.30	2 7.80	7 0	8 11.10	18 6.60	13 0	16 6.90	34 5.40	19 0	24 2.70	50 4.20	25 0	31 10.50	66 3.00
1 3	1 7.12	3 3.75	7 3	9 2.92	19 2.55	13 3	16 10.72	35 1.35	19 3	24 6.52	51 0.15	25 3	32 2.32	66 10.95
1 6	1 10.95	3 11.70	7 6	9 6.75	19 10.50	13 6	17 2.55	35 9.30	19 6	24 10.35	51 8.10	25 6	32 6.15	67 6.90
1 9	2 2.77	4 7.65	7 9	9 10.57	20 6.45	13 9	17 6.37	36 5.25	19 9	25 2.17	52 4.05	25 9	32 9.97	68 2.85
2 0	2 6.60	5 3.60	8 0	10 2.40	21 2.40	14 0	17 10.20	37 1.20	20 0	25 6.00	53 0.00	26 0	33 1.80	68 10.80
2 3	2 10.42	5 11.55	8 3	10 6.22	21 10.35	14 3	18 2.02	37 9.15	20 3	25 9.82	53 7.95	26 3	33 5.62	69 6.75
2 6	3 2.25	6 7.50	8 6	10 10.05	22 6.30	14 6	18 5.85	38 5.10	20 6	26 1.65	54 3.90	26 6	33 9.45	70 2.70
2 9	3 6.07	7 3.45	8 9	11 1.87	23 2.25	14 9	18 9.67	39 1.05	20 9	26 5.47	54 11.85	26 9	34 1.27	70 10.65
3 0	3 9.90	7 11.40	9 0	11 5.70	23 10.20	15 0	19 1.50	39 9.00	21 0	26 9.30	55 7.80	27 0	34 5.10	71 6.60
3 3	4 1.72	8 7.35	9 3	11 9.52	24 6.15	15 3	19 5.32	40 4.95	21 3	27 1.12	56 3.75	27 3	34 8.92	72 2.55
3 6	4 5.55	9 3.30	9 6	12 1.35	25 2.10	15 6	19 9.15	41 0.90	21 6	27 4.95	56 11.70	27 6	35 0.75	72 10.50
3 9	4 9.37	9 11.25	9 9	12 5.17	25 10.05	15 9	20 0.97	41 8.85	21 9	27 8.77	57 7.65	27 9	35 4.57	73 6.45
4 0	5 1.20	10 7.20	10 0	12 9.00	26 6.00	16 0	20 4.80	42 4.80	22 0	28 0.60	58 3.60	28 0	35 8.40	74 2.40
4 3	5 5.02	11 3.15	10 3	13 0.82	27 1.95	16 3	20 8.62	43 0.75	22 3	28 4.42	58 11.55	28 3	36 0.22	74 10.35
4 6	5 8.85	11 11.10	10 6	13 4.65	27 9.90	16 6	21 0.45	43 8.70	22 6	28 8.25	59 7.50	28 6	36 4.05	75 6.30
4 9	6 0.67	12 7.05	10 9	13 8.47	28 5.85	16 9	21 4.27	44 4.65	22 9	29 0.07	60 3.45	28 9	36 7.87	76 2.25
5 0	6 4.50	13 3.00	11 0	14 0.30	29 1.80	17 0	21 8.10	45 0.60	23 0	29 3.90	60 11.40	29 0	36 11.70	76 10.20
5 3	6 8.32	13 10.95	11 3	14 4.12	29 9.75	17 3	21 11.92	45 8.55	23 3	29 7.72	61 7.35	29 3	37 3.52	77 6.15
5 6	7 0.15	14 6.90	11 6	14 7.95	30 5.70	17 6	22 3.75	46 4.50	23 6	29 11.55	62 3.30	29 6	37 7.35	78 2.10
5 9	7 3.97	15 2.85	11 9	14 11.77	31 1.65	17 9	22 7.57	47 0.45	23 9	30 3.37	62 11.25	29 9	37 11.17	78 10.05
6 0	7 7.80	15 10.80	12 0	15 3.60	31 9.60	18 0	22 11.40	47 8.40	24 0	30 7.20	63 7.20	30 0	38 3.00	79 6.00
6 3	7 11.62	16 6.75	12 3	15 7.42	32 5.55	18 3	23 3.22	48 4.35	24 3	30 11.02	64 3.15	30 3	38 6.82	80 1.95
6 6	8 3.45	17 2.70	12 6	15 11.25	33 1.50	18 6	23 7.05	49 0.30	24 6	31 2.85	64 11.10	30 6	38 10.65	80 9.90
6 9	8 7.27	17 10.65	12 9	16 3.07	33 9.45	18 9	23 10.87	49 8.25	24 9	31 6.67	65 7.05	30 9	39 2.47	81 5.85

THE LONDON IMPERIAL COAL MEASURE CONVERTED INTO WEIGHT.

Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.	Chals.	Tons.	Cwt.
1	1	5½	44	56	2	87	110	18½	130	165	15	173	220	11½	216	275	8	259	330	4½
2	2	11	45	57	7½	88	112	4	131	167	0½	174	221	17	217	276	13½	260	331	10
3	3	16½	46	58	13	89	113	9½	132	168	6	175	223	2½	218	277	19	261	332	15½
4	5	2	47	59	18½	90	114	15	133	169	11½	176	224	8	219	279	4½	262	334	1
5	6	7½	48	61	4	91	116	0½	134	170	17	177	225	13½	220	280	10	263	335	6½
6	7	13	49	62	9½	92	117	6	135	172	2½	178	226	19	221	281	15½	264	336	12
7	8	18½	50	63	15	93	118	11½	136	173	8	179	228	4½	222	283	1	265	337	17½
8	10	4	51	65	0½	94	119	17	137	174	13½	180	229	10	223	284	6½	266	339	3
9	11	9½	52	66	6	95	121	2½	138	175	19	181	230	15½	224	285	12	267	340	8½
10	12	15	53	67	11½	96	122	8	139	177	4½	182	232	1	225	286	17½	268	341	14
11	14	0½	54	68	17	97	123	13½	140	178	10	183	233	6½	226	288	3	269	342	19½
12	15	6	55	70	2½	98	124	19	141	179	15½	184	234	12	227	289	8½	270	344	5
13	16	11½	56	71	8	99	126	4½	142	181	1	185	235	17½	228	290	14	271	345	10½
14	17	17	57	72	13½	100	127	10	143	182	6½	186	237	3	229	291	19½	272	346	16
15	19	2½	58	73	19	101	128	15½	144	183	12	187	238	8½	230	293	5	273	348	1½
16	20	8	59	75	4½	102	130	1	145	184	17½	188	239	14	231	294	10½	274	349	7
17	21	13½	60	76	10	103	131	6½	146	186	3	189	240	19½	232	295	16	275	350	12½
18	22	19	61	77	15½	104	132	12	147	187	8½	190	242	5	233	297	1½	276	351	18
19	24	4½	62	79	1	105	133	17½	148	188	14	191	243	10½	234	298	7	277	353	3½
20	25	10	63	80	6½	106	135	3	149	189	19½	192	244	16	235	299	12½	278	354	9
21	26	15½	64	81	12	107	136	8½	150	191	5	193	246	1½	236	300	18	279	355	14½
22	28	1	65	82	17½	108	137	14	151	192	10½	194	247	7	237	302	3½	280	357	0
23	29	6½	66	84	3	109	138	19½	152	193	16	195	248	12½	238	303	9	281	358	5½
24	30	12	67	85	8½	110	140	5	153	195	1½	196	249	18	239	304	14½	282	359	11
25	31	17½	68	86	14	111	141	10½	154	196	7	197	251	3½	240	306	0	283	360	16½
26	33	3	69	87	19½	112	142	16	155	197	12½	198	252	9	241	307	5½	284	362	2
27	34	8½	70	89	5	113	144	1½	156	198	18	199	253	14½	242	308	11	285	363	7½
28	35	14	71	90	10½	114	145	7	157	200	3½	200	255	0	243	309	16½	286	364	13
29	36	19½	72	91	16	115	146	12½	158	201	9	201	256	5½	244	311	2	287	365	18½
30	38	5	73	93	1½	116	147	18	159	202	14½	202	257	11	245	312	7½	288	367	4
31	39	10½	74	94	7	117	149	3½	160	204	0	203	258	16½	246	313	13	289	368	9½
32	40	16	75	95	12½	118	150	9	161	205	5½	204	260	2	247	314	18½	290	369	15
33	42	1½	76	96	18	119	151	14½	162	206	11	205	261	7½	248	316	4	291	371	0½
34	43	7	77	98	3½	120	153	0	163	207	16½	206	262	13	249	317	9½	292	372	6
35	44	12½	78	99	9	121	154	5½	164	209	2	207	263	18½	250	318	15	293	373	11½
36	45	18	79	100	14½	122	155	11	165	210	7½	208	265	4	251	320	0½	294	374	17
37	47	3½	80	102	0	123	156	16½	166	211	13	209	266	9½	252	321	6	295	376	2½
38	48	9	81	103	5½	124	158	2	167	212	18½	210	267	15	253	322	11½	296	377	8
39	49	14½	82	104	11	125	159	7½	168	214	4	211	269	0½	254	323	17	297	378	13½
40	51	0	83	105	16½	126	160	13	169	215	9½	212	270	6	255	325	2½	298	379	19
41	52	5½	84	107	2	127	161	18½	170	216	15	213	271	11½	256	326	8	299	381	4½
42	53	11	85	108	7½	128	163	4	171	218	0½	214	272	17	257	327	13½	300	382	10
43	54	16½	86	109	13	129	164	9½	172	219	6	215	274	2½	258	328	19			

REDUCED PRICES OF IRON.

As a matter of curiosity, and for the information of the younger class of coal owners and colliery agents, I give, below, the contrasted prices of iron—cast and malleable—in the years 1812 and 1844; than which, I believe, no one trade of this country, unaffected (as this has been) by fiscal changes, can show so extraordinary a declension in a staple product. The cause has not been much assisted by an abated charge of labour—that indeed has been, comparatively, trifling—but mainly by improved modes of manufacture, aided, in a lesser degree, by the reduction of freights, and a curtailment of profits, occasioned by an extraordinarily ramified competition, which the increased demand (trebled in the period alluded to), and the abundance, and low value of money, promoted.

PRICES OF FOUNDRY GOODS AT NEWCASTLE-ON-TYNE.

1st January 1812. *Per Cwt.*	DESCRIPTION OF ARTICLES.	*1st January* 1844. *Per Cwt.*
17s.	Chaldron waggon wheels ...	5s. to 6s.
23s. 4d.	Rolly (edge and crested) wheels	7s.
25s. 8d.	Tram wheels	9s.
15s.	Chaldron waggon-way rails...	5s. 6d.
15s.	Rolly-way plates and rails ...	6s. 6d.
17s.	Tram-way plates...	6s. 6d.
16s.	Flooring plates	6s.
23s. 4d. to 28s.	Skreen bars	7s. to 8s.
13s.	Engine grate bars	3s. 6d. to 4s. 6d.
24s.	Steam cylinders	10s.
34s.	Ditto ditto, bored	16s.
16s. to 21s.	Engine close-sand castings...	7s. to 8s.
28s.	Ditto ditto, in loam ...	10s. to 12s.
17s. to 21s.	Common pump pipes ...	5s. 6d. to 6s. 6d.
34s. to 36s.	Working barrels, bored ...	12s.
8s.	Pig iron on Newcastle Quay	2s.

THE MERCHANTS' PRICES OF MALLEABLE IRON AT NEWCASTLE-ON-TYNE.

1st January, 1812. *Per Cwt.*	DESCRIPTION.	*1st January*, 1844. *Per Cwt.*
22s. 0d.	Bar iron, common sizes	5s. 6d.
23s. 0d.	Ditto, extra and hammered	8s. 9d.
26s. 0d.	Bolts, ½, ⅝, and ¾ inch	8s. 0d.
33s. 0d.	Sheet iron, single rolled	9s. 0d.
46s. 8d.	Ditto, double ditto	10s. 6d.
33s. 0d.	Boiler plates	9s. 0d.
31s. 0d.	Corf bows of scrap iron	14s. 0d.
31s. 0d.	Engine work and bars to dimensions	14s. 0d.
33s. 0d.	Spear plates of scrap iron	15s. 0d.

Since the last of the above dates, iron of all descriptions, has advanced considerably; arising, principally, from the great increase of railways and the consequent extraordinary demand for it.

On the 1st January, 1847, quotations at Newcastle Quay, as compared with the 1st January, 1844, may be taken to rule in advance, as follows, viz.:—

Pig iron	50 to 55 ℔ cent.	higher.
Foundry castings	45 to 50	do.	do.
Rolled and forged iron ...	55.	do.	do.

The following aggregate depths taken from "Forster on the Strata of the Coal Field of Northumberland and Durham," I have given as a matter of some interest to many, who may not have taken the trouble to extract it.

The Tyne High Main Seam to the Low Main	120	yards.
The Low Main to the Brockwell Seam ...	86	„
The Brockwell Seam to the Millstone Grit ...	50	„
The Millstone Grit to the Blue Limestone ...	250	„
The Limestone to the Green Whinstone ...	200	„
The Green Whinstone to the Red Sandstone	400	„
Tyne High Main to the Red Sandstone	1106	yards.

RAILWAY PRACTICE.

The various subjects, under this head, that follow, comprehend a practical experience of many years; reaching back to a period when public attention had not been drawn to the subject of railroads; yet will they be found, I believe, when tested by science and modern acquirements, to furnish a very near approximation to rules and laws laid down, and the practical knowledge now gained.

HORSE-POWER.

The mechanical operations on railroads being generally measured by the (so called) horse-power, it becomes necessary, in the first place, to say something on that subject.

The computed horse-power, for mechanical purposes, generally adopted by engineers, is the same that the celebrated Mr. Watt laid down as a rule for his own guidance, in reference to his steam-engines. He found that the horses used in and about the large breweries and mills of the metropolis, were competent to the following performance, for eight hours out of the four and twenty, viz., that their draught was equivalent to the lifting a weight of 150 lbs. out of a well by a rope passing over a pulley, such weight being raised at the animal's natural travelling speed of 220 feet per second, or 2½ miles an hour, *i. e.* $150 \times 220 = 33{,}000$ pounds raised one foot high in a minute. Mr. Watt's engines were then beginning to be

used, in many instances, instead of those horses, and hence it was that he adopted, as a formula for the measure of his engine-power, *that* of the animal which it superseded.

The colliery waggon horses of Northumberland and Durham, although inferior in size to the London dray-horses, are very little, if at all, inferior to them in a comparison of work performed. I am well satisfied, however, that the railway waggon horses in question, achieve, for a day's duty, a result fully realising Mr. Watt's calculation, and very often—indeed generally—more.

RAILWAY TRACTION.

In conjunction with the late Mr. John Grimshaw, of Fatfield colliery, who at that period (1820 and 21) was a partner in, and the manager of, the concern, and who carried out many carefully conducted experiments with reference to railway traction, the following rules were established by us, for general guidance, at that time of day.

1st. That the friction of an empty chaldron waggon, weighing 23 cwt., drawn along a level plane, constituted a draught of 10lbs.

2nd. That the friction of such waggon when filled with 53 cwt. (a statute chaldron) of coals, drawn along a level plane, constituted a draught of 50lbs.

3rd. That an inclined plane of 0·20 inch per yard, 4½ inches per chain, 30 feet per mile, or 1 in 176, was the angle of inclination between rest and motion, and, consequently, furnished the amount of gravity [illegible] was, therefore, the measure of [illegible]

The last, will be found very nearly to agree with the 2nd rule, for, $4\frac{1}{2}$ inches per chain, (792 inches), or $\frac{4\frac{1}{2}}{792}$, or $\frac{1}{176}$, or $\frac{1}{176}$ of 8512 (23 cwt. + 53 cwt × 112 lbs.) = 48·36 lbs. the measure of friction on a loaden chaldron of coals, upon a level plane, and as something is required to give motion, 1·64 lbs. may very well be added thereto for that purpose = 50 lbs.

The following table, founded on the above rules, and made out at the remote period alluded to, gives the force of traction exerted by a horse upon planes rising from a level to one inch in the yard, based on the chaldron waggon of coals being (23 + 53 × 112 =) 8,512 pounds.* The first line gives the gradients—the second line, the forces of traction in pounds—the third line, the chaldrons, and decimal portions of a chaldron, which a horse is able to draw, as a working load up the several planes—and the fourth line gives the weight in pounds to which the preceeding line is equivalent.

Level.	$\frac{1}{8}$ inch ℔ yard.	$\frac{1}{4}$ inch ℔ yard.	$\frac{3}{8}$ inch ℔ yard.	$\frac{1}{2}$ inch ℔ yard.	$\frac{5}{8}$ inch ℔ yard.	$\frac{3}{4}$ inch ℔ yard.	$\frac{7}{8}$ inch ℔ yard.	1 inch ℔ yard.
50 lbs.	80 lbs.	110 lbs.	140 lbs.	170 lbs.	200 lbs.	230 lbs.	268 lbs.	290 lbs.
4 chs.	2.5 chs.	1.818 chs.	1.428 chs.	1.176 chs.	1 ch.	0.869 ch.	0.769 ch.	0.689 ch.
34,048 lbs.	21,180 lbs.	15,474 lbs.	12,155 lbs.	10,010 lbs.	8,512 lbs.	7,396 lbs.	6,545 lbs.	5,864 lbs.

In this table the tractive power of a horse is taken to be 4 loaden chaldron waggons, at 50 lbs. each, along a level plane, which is a draught of 200 lbs.; but three such loaden waggons, drawn 20 miles, would constitute a fair day's work. This requires some explanation. Upon the colliery rail-roads, the loaden waggons are

* The chaldron waggon weighed, very frequently, not more than 20 or 21 cwt. upon rail-roads where two, and sometimes a single waggon only, was drawn by a horse, the motion being slow, and the lightness of the waggon an important consideration. Afterwards, when they were run in numbers on inclined planes, but still further, when drawn by locomotive engines, and their speed in both cases greatly accelerated, their strength was progressively increased, until they weighed 29 and 30 cwt.

drawn in the forward direction of the staith only, the horse bringing back the same number of empty ones. Thus employed, he will go over 24 miles for his day's work upon a level plane, with 4 waggons, viz., 12 miles with the loaden, and 12 miles with the empty waggons. These performances—that is, 20 miles with 3 loaden waggons, and 24 miles with 4 waggons loaden and empty for each half of that distance—may be contrasted, so far as the tractive forces are concerned, by the following figures—viz., first, the 3 loaden waggons for 20 miles, $150 \times 20 = 3{,}000$—second, the 4 waggons loaden for 12 miles, $200 \times 12 + 40 \times 12$ for the other part of the performance $= 2{,}880$; but it must be borne in mind that the horse, in the latter case, travels — though with a less draught — over one-fifth more ground, which makes his task, in point of fact, the severer one. But I have known the latter case extremely well, and steadily, sustained.

Upon a good railway, a descending plane of $\frac{1}{8}$ of an inch in the yard $= 18\frac{1}{3}$ feet in the mile—or 1 in 288—the draught of the loaden waggons downward, and the empty ones up the same, will very nearly equalise the tractive forces, and, therefore, for choice, this inclination would be preferred, for a colliery horse way, where it can be had.

It is due to modern practice to correct the results brought out, so many years ago, by Mr. Grimshaw and myself.

The civil engineers of the present day are not as yet quite agreed on the force due to traction on a level plane, or, in other words, on the measure and value of friction.

M. Navin calls it one two-hundredth part of the weight, viz., 11 lbs. per ton $= \frac{11}{2240} = \frac{1}{200}$ very nearly. Messrs. Walker & Rastrick, in their report to the directors of the Manchester and Liverpool Railway in 1829 power to be adopted

by them" (*vide* page 40), worked their calculations by the same number, viz., $\frac{1}{200}$ of the weight drawn; and I have myself, for many years, made use of the same factor. But recently, 9 lbs. per ton $= \frac{9}{2240} = \frac{1}{249}$ has been held to be the measure of friction.

$\frac{1}{200}$th part is equivalent to a gradient of 0·18 of an inch per yard $=$ 3·96 inches per chain $=$ 26.4 feet per mile $=$ 1 in 200; which inclination is, what is termed, the angle of repose, or such an inclining position of the rails as will balance the waggon between rest and motion — the least touch (where the fitting up is very perfect) moving or retarding it. The angle of repose, in the other case, being 0·144 inch per yard $=$ 3·18 inches per chain $=$ 21·22 feet per mile $=$ 1 in 249.

The elements of the draught, or force of traction, up an inclined plane, consist of gravity and friction. They are found by a division of the load, or weight, to be drawn, in pounds, by the gradient, for the first; and by a division of such load by 200, for the second; these two added, constitute the tractive force required.

The force of traction upon a level plane, consists merely of friction, and, therefore, the value of it is come at by dividing the weight in pounds to be drawn, by 200, the quotient being the draught required.

The table of tractive forces, given as experimentally deduced by the late Mr. Grimshaw and myself, I shall now correct by modern experience, adopting for the basis, the formula above laid down, viz., $\frac{1}{200}$th part of the load for the friction.

I have chosen this factor—viz., $\frac{1}{200}$th of the weight drawn—for the next table, because it more nearly accords with my bygone practice; yet there can be no doubt of 9 lbs. per ton ($\frac{1}{249}$th) being the more correct value of friction. The two following tables are entirely new, and will be found to be useful.

Level,	⅛ in. ꝑ y.	¼ in. ꝑ y.	⅜ in. ꝑ y.	½ in. ꝑ y.	⅝ in. ꝑ y.	¾ in ꝑ y.	⅞ in. ꝑ y.	1 in. ꝑ y.
Level,	Feet. 18,333 p.m.	Feet. 36,666p.m.	Feet. 55 p. m.	Feet. 73,333p.m.	Feet. 91,666p.m.	Feet. 110 p.m.	Feet 128,333p.m.	Feet. 146,666p.m.
Level,	1 in 288.	1 in 144.	1 in 96.	1 in 72.	1 in 57.6.	1 in 48.	1 in 41.142.	1 in 36.
The following are the forces constituting the draught of a waggon of coals (23 cwt. + 53 cwt. = 8,512 lbs.) in lbs.								
42.56	72.11	101.67	131.22	160.72	190,33	219.89	249.45	279.

The first and last lines have reference to the first and second of the former table (page 93); the second and third, being merely the first line carried further out

By comparing these tables, viz., the above with that of page 93, it will be seen, that there is no very important disagreement, and that calculations founded on the former one, would furnish *safe* results to go by.

GRAVITY AND FRICTION ON RAILWAY PLANES

Which I have drawn up, under the more modern rule of friction being 9 lbs. per ton, or one 249th part of the load, to suit a series of gradients.

Gradients.	Gravity ꝑ Ton of 2,240 lbs.	Gravity and Friction.	Comparative Tractive Power.	Gradients.	Gravity ꝑ Ton of 2,240 lbs.	Gravity and Friction.	Comparative Tractive Power.
one in	lbs.	lbs.	lbs.	one in	lbs.	lbs.	lbs.
70	32.00	41.00	22.00	250	8.96	17.96	50.12
80	28.00	37.00	24.00	300	7.46	16.46	54.67
90	24.88	33.88	26.00	400	5.60	14.60	61.64
100	22.40	31.40	28.66	500	4.48	13.48	66.76
110	20.36	29.36	30.65	750	3.00	12.00	75.00
120	18.66	27.66	32.53	1000	2.24	11.24	80.00
130	17.23	26.23	34.31	1500	1.49	10.49	85.79
140	16.00	25.00	36.00	2000	1.12	10.12	88.93
150	14.93	23.93	37.60	2500	0.89	9.89	91.00
175	12.80	21.80	41.28	3000	0.74	9.74	92.40
200	11.20	20.20	44.55	4000	0.56	9.56	94.14

This table is formed as follows. The first three columns will be understood from what has been previously stated. The fourth is thus obtained. As 41.0 (the tractive power necessary to overcome gravity and friction up a gradient of 1 in 70) is to 9 (the draught for 1 ton upon a level plane), so is 100 to 22, the comparatively diminished effective power; or, as a level plane to the gradient.

SELF-ACTING, OR GRAVITATING, INCLINED PLANES.

This description of colliery railway accommodation, is now become so very common, that but few mines are without something of the kind, either above or underground; and, certainly, it is a most convenient and useful device, saving as it does, in many instances, a great expense in horses, and rendering easy and safe underground, roads which, otherwise, would be dangerous.

I shall supply a few practical rules, under this head, as best suited to the colliery engineer, being the result of long and careful observation; for the question, scientifically considered, involves a rather complex operation of figures for the necessary working of it, viz., 1, the gravity and friction of the descending loaden waggons; 2, the gravity and friction of the ascending empty ones; 3, the gravity and friction of the rope, or ropes. These are ingredients necessarily forming the calculation in order to arrive at the lowest practicable gradients for self-acting planes, to be worked by trains of waggons of different numbers. My experience enables me to show, at once, what these minimum gradients are; at least so far as the furnishing of three cases will serve the purpose; which I consider to be sufficient for the practical man.

1. I have found that 8 loaden waggons (containing a chaldron of coals each, of course) descending a plane of ⅝ of an inch per yard = 91 feet 8 inches per mile—or 1 in 57½; will bring upward the like number of empty ones, at a good working speed.
2. Six loaden waggons will require a fall of ¾ of an inch per yard = 110 feet per mile—or 1 in 48, to effect the like purpose.
3. And that 4 loaden waggons must have an inclination of ⅞ of an inch per yard = 128 feet 4 inches per mile—or 1 in 41.

FIXED ENGINE INCLINED PLANES.

As the clearest and best manner of treating this question, I shall adduce a very simple case, viz., a plane, with a single line of road, one drum wheel, and one rope; which is stripping the subject of all complexity.

In this instance, the loaden waggons are drawn up, and the empty ones run down, by distinct and separate operations; each one requiring for its performance, the same time, or thereabout; being double the period requisite for a plane of a twofold action, in which the upward and downward runs are simultaneous. The result necessarily is, therefore, that only half the amount of work can be done. There are, however, many situations where every purpose is fully answered by this means; and where it suffices to meet the required wants, it is preferable; as a simpler outfit, and fewer hands are needed, and the work is, consequently, more easily done, and at a less charge.

... question, the object is equally well met by the ...ngle operation; for the descent of the empty

waggons in the double one, need form no part of the case, as they render little, or no aid, to the traction of the loaden ones upward, answering in general, the purpose only of hauling out their own rope—at least, this is commonly the case, and the plane must be a very steep one indeed to serve any object as an auxiliary to the engine.

For the purpose of solving the problem, I shall take the case of an inclined plane half a mile in length, with a gradient of $\frac{3}{8}$ of an inch in a yard = 55 feet per mile—or 1 in 96—a train of 8 loaden chaldron waggons being required to be drawn upward at a speed of 10 miles per hour; the waggons weighing 27 cwt. each, and the chaldron of coals assumed to be 54 cwt.,* together (81 cwt. × 112 × 8)=72,576 lbs.; the rope girting $5\frac{1}{2}$ inches, and the length of it (for calculation), half the length of the plane, viz., 220 fathoms will weigh 1,774 lbs.†

It has already been stated that for the force of gravity the load must be divided by the gradient, and for that of friction by 200—as to the friction of the rope, 50 as a divisor, will serve where the plane is straight—30 when the curves are easy and not numerous; but when, on the other hand, there is a considerable curvature in the line, and their radii somewhat small, 18 may be used.

EXAMPLE:

	lbs.	lbs.
The waggon and the coals	72,576 ÷ 96 =	756.00 gravity.
	72,576 ÷ 200 =	362·88 friction.
The rope	1,774 ÷ 96 =	18.47 gravity.
	1,774 ÷ 50 =	35·48 friction.
Total force or the resistance to be overcome		1,172·83 lbs.

* The statute chaldron is 53 cwt., but the waggons commonly carry 54 cwt.

† The following is a ready, and very correct, method of finding the weight of cordage. Multiply the square of the girt in inches by the length in fathoms, and divide by the constant number 420, and the quotient will be the cwts., &c.

EXAMPLE: $5\frac{1}{2}^2 = 30\frac{1}{4} \times 220 \div 420 = 1,774$ lbs. or 15 cwt. 3 qrs. 10 lbs.

1,172·83 × 5280 (the feet in a mile) × 10 (the speed in miles ℔ hour) ÷ 60 (minutes in an hour) = 1,032,090·4 ÷ 33,000·0 (the horse power) = 31·27 horse power; to which must be added one third for the friction of the engine and machinery; or it may be called 10·73, making the requisite power of the engine 42 horse power.

The weight of the rope, and the consequent force of gravity and friction, will necessarily be greatest when the loaden waggons are first put in motion from the bottom of the plane, which force diminishes continually until their arrival at the top, where it is nothing. Hence, the calculation deals with half, or the medium, weight of the rope; but it is desirable, where the nature of the surface will admit of it, so to form the plane as to cause the gradients to increase (but by exceedingly small degress) progressively from bottom to top—as for instance, were it practicable to do so, instead of an uniform gradient of 1 in 96, to commence with 1 in 104 at the foot, or nearly so, and end with about 1 in 88. This, or some near approximation thereto, would tend to render the tractive force more uniform.

RAILWAY TRACTION BY LOCOMOTIVE ENGINES.

The application of this species of power, on colliery railways, is become very common, and will, probably, be still more frequently resorted to, seeing the great improvements that have been made, and are still in progress, as to the construction and general economy of the engine. It is, therefore, quite in accordance with the object of the present work to say something on the power of this machine on railways.

Irrespective of the value and importance of the resulting speed, there is, perhaps, no other instance to be adduced where the waste of applied means is so great as in the case of the locomotine engine, running 25 or 30 miles (and at higher speeds still) per hour, on a rail-road.

The velocity at which railway travelling has arrived, is truly wonderful, and after what has been effected, it is impossible to say what it may not yet further attain. But great speeds can only be bought at high prices. This I shall be able to exemplify by the application of figures, which will speak for themselves better than any course of reasoning.

A locomotive engine with 14 inch cylinders, 18 inch strokes, 5½ feet driving wheels, and running at a speed of 30 miles an hour, makes 152·86 complete (double) strokes per minute in each cylinder, the pistons moving through a space of 458·58 feet in the same time—Watt's maximum velocity for pistons being 220 feet per minute.

A fixed engine of these dimensions, using steam of 50 lbs. pressure on the square inch, and working at the last-named rate (220 feet per minute) would yield 68·41 horse power. But the locomotive engine travelling 30 miles an hour, would consume 1,078·44 cubic feet of steam per minute, of the density named (50 lbs. per square inch), which, reduced to an atmospheric volume is 4,284 cubic feet, and this divided by Mr. Watt's rule of 33 feet of atmospheric steam per minute to realise a horse power, furnishes an expenditure of steam equivalent to the ordinary supply to fixed condensing engines, of 130 horse power. Whereas the real effective result, deduced from the tractive force actually applied in the case, would not be more than 40 to 45 horses.

This enormous loss of power may be variously explained—the rapidity of the pistons' movements in a direction—away from the

steam's pressure — their following (pressingly) upon the discharging steam, which is greatly restrained by the blast pipe—the friction assignable to the extraordinary speed of its various movements—and its own weight (engine 12 tons, tender with coke and water 7 tons) which constitutes, by no means, an inconsiderable portion of the moving load — these causes will, I think, answer pretty fully for the great mechanical waste of means afforded.

The method of calculating the resisting forces to locomotive traction on rail-roads, is the same as in the foregoing cases, only, that the weight of the engine and its tender may be considered in a certain degree a substitution for the rope. Thus, in estimating the resistance on a plane rising ¼ of an inch in the yard = 36⅔ feet in the mile—or 1 in 144; for a single waggon of 27 cwt., and its load of 54 cwt., making together 9,072 lbs., the force due thereto, will be as follows, the rated speed being 10 miles an hour.

	lbs.	lbs.	
1 waggon and its load	9,072 ÷ 144	= 63·00	gravity.
	9,072 ÷ 200	= 45·36	friction.
Total force of resistance		108·36	

$$108{\cdot}36 \times 5{,}280 \times 10 \div 60 \div 33{,}000 = 2{\cdot}88 \text{ horse power.}$$

Travelling thus, 10 miles an hour, the power really dealt out by the locomotive cannot be called more than 49 or 50 horses, although, in the case of a fixed high pressure engine, of similar dimensions, and steam pressure, duly wrought, the power, as before said, would be 68 horses. Now 49 horse power should be master of 17 loaden chaldron coal waggons, but 5 of the number may be taken off as equivalent to the engine and tender, leaving 12 as constituting the train so taken along.

But the progressive capability of a railway locomotive engine is dependent on the adhesion of its wheels to the rails.

M. Vignoles, in his lectures, has furnished a clear view and estimate of this matter, which I cannot possibly do better than give in his own words.

"In estimating the powers of locomotive engines on rail-roads, the limitation to their capabilities, offered by the adhesion of the wheels to the rails, presents a matter for necessary consideration.

Plain surfaces of iron rubbing against each other, require one-sixth, or one-seventh, of the insistent weight, to produce motion; but for locomotive engines on railways, it is commonly assumed at one-fifteenth. Example.—Take the weight upon the driving wheels of the engine to be 7 tons, or 15,680 lbs.—one fifteenth is 1,042 lbs.* but say 1,000 lbs. for the available adhesive power.

The inclination of the road affects the adhesive power. Between the perpendicular, in which there is no adhesion, and the horizontal, on which there will be the most, the degrees of adhesive power constantly vary. On a plane of 1 in 100 the gravity of the engine per ton (2,240 lbs.) will be $\frac{2240}{100} = 22.4$ lbs.—and on 7 tons, $22.4 \times 7 = 157$ lbs., which subtracted from 1,000 gives 843 for the diminished amount of adhesion, or the real limit of such an engine's power, on such a plane, as regards the load, no matter how great the power of the engine itself."

LIMITATION OF A LOCOMOTIVE ENGINE'S POWER BY ADHESION TO THE RAILS, SHOWN IN FIVE CASES.

Gradients.	Adhesive Power.	℔ Centage Power.
	lbs.	
Horizontal.	1042*	100.
1 in 100	885	84.
1 in 90	867$\frac{3}{4}$	83.
1 in 80	846	81.
1 in 70	818	78.

The constitution of the table will be easily understood, being merely illustrative of M. Vignoles' text; and the series may be extended without difficulty. Fractional parts, it will be seen, have been omitted.

THE WEAR OF CAST METAL, CASE-HARDENED, CHALDRON-WAGGON WHEELS.

Over the Ouston waggon way (7 miles long) 171,049 chaldrons of coals were conveyed in 6 years, ending with 1821, and 93 tons 7 cwt. 0 qr. 3 lbs. weight of metal was expended in fairly supplying the wear and tear, the wheels being (of course at that period) made from cold blast iron, and case-hardened. The price of them was on an average 12s. per cwt., the old metal being held to be one-third the value of the new. According to which data the cost per chaldron on the whole length of way was 1·04d.—and 0·15d. per chaldron per mile, or, 0·056d. per ton per mile.

Coal-waggon wheels, used on locomotive engine lines, are generally made of malleable iron; and very necessary it is that they should be so, in order to sustain the severe trials they are put to in their high speeds of travelling; the more especially since the introduction of iron made by the reduction of the ores with highly-heated air, or hot-blast; which has rendered crude iron of so cold-short a nature that for purposes of tenacity and wear, its value is exceedingly diminished; and for such wheels to move at any of the higher velocities assignable to locomotion, would be attended with the extremest danger. I have not been able to learn what the cost of malleable iron wheels is upon the ton per mile; but the question of charge, in a case with which human life, on so extensive a scale, is intimately connected, is inadmissible; although from their greater durability, as a thing of course, it is probable their expense will not be much, if any, more than those of cast iron, notwithstanding the great cost of their fabrication.

THE WEAR OF CAST IRON RAILS.

I have had an opportunity of ascertaining, in the case of a rail-road over which 200,000 tons weight were conveyed annually, during a period of 18 years (comprising the carriages and their loadings of coals in one direction, viz., 150,000 tons; and the empty waggons, only, in the other, viz., 50,000 tons), that the mechanical waste, from attrition, was one pound in every lineal foot of rail (2 lbs. per foot of way) or thereabouts, in the course of the time named; which is 587 lbs. per mile of road, per annum; the rails being cast from cold-blast pig iron. It may not be generally known, but I believe it to be true, that there is no chemical waste going on with rails in regular use, a certain degree of heat, occasioned by the loads passing over them, preventing oxidation. The wear of hot-blast cast iron rails will be considerably greater, and by breakage still more. It is, indeed, a very difficult matter to assign to them a competent weight and strength—one-half more metal would, I much doubt, scarcely be sufficient for the purpose.

I do not think it has yet been satisfactorily shown what the loss in weight, by wear, of malleable iron rails, is; but it cannot fail to be considerably less than those of cast iron. It is, indeed, a fact well known, and supported by theory, that the more highly iron is wrought, and the purer it is rendered, by being purged of earthy dross in its transmutation from the crystalline to the fibrous state; the stronger and more durable it will be; whether as regards its subjection to the action of fire, to attrition, or mechanical stress—in the character of engine grate bars, waggon-way rails, and wheels, tye bars, &c., &c.

INTERESTING AND USEFUL INFORMATION

RELATIVE TO

MR. WATT'S STEAM ENGINE.

This noble invention—Watt's condensing engine—has conferred, probably, a greater benefit on mankind, than anything that ever emanated from the mind and labours of an individual; and, it is a very extraordinary fact, that only in finish and arrangement, has it undergone any improvement since his completion of it; notwithstanding that so many years have elapsed, and an age, comprehending more general talent, enterprise, and demand, has intervened, than at any previous period, perhaps, of the world. That happy effort of genius, the detached condensation—the substitution of steam pressure for the atmospheric—the expansive use of steam—the parallel motion, and the perfect proportions of all the parts scientifically determined—are all, in a manner, untouched, and remain a memorial of his intellectual and successful labours.

The following rules, made and adopted by Mr. Watt, are, for the most part, those which govern engineers at the present day — at least, the practical man will be very nearly right in being guided by the first five. The others have been improved upon considerably, by the application of the expansive principle, aided by the high finish, and, consequently, greater mechanical perfection of the machine.

1. That in a well-constructed furnace, it required 480 square feet of the surface of the boiler to be exposed to the action of the fire and flame, to boil off a cubic foot of water in a minute.
2. That a bushel (84 lbs.*) of Newcastle coals so applied, would boil off from 8 to 12 cubic feet of water; which is at the rate of from 6 to 9 lbs. of water evaporated by each pound of coals—or, for practical purposes, it may be assumed, that a bushel will boil off 10·08 cubic feet of water.

* This is the weight of the bushel according to Mr. Watt, *vide* table, page 108.

3. That 84 lbs. of good Newcastle coals were equal to 112 lbs. of the best Wednesbury (Staffordshire) coals.
4. That a cubic inch of water produced a cubic foot of steam, of an elasticity capable of driving the single condensing engine 96 feet (complete stroke 192 feet) per minute, when loaded with a column of water equivalent to 8·68 lbs. per square inch of the piston.
5. That the actual expenditure of steam was one-tenth more than the capacity of that space, within the cylinder, occupied by the piston in its motion, to allow for the extra spaces at the top and bottom of the cylinder; and that the expenditure of steam, for every horse power, was 33 cubic feet per minute, such steam being of atmospheric force.
6. That a pressure of 8·68 lbs. per square inch of the piston is equivalent to a column of water 20 feet high, and the expenditure of steam being one-tenth more than the space occupied by the piston, there results ($20 \div 1 \cdot 1 =$) 18·18 feet effective, or, that a cubic foot of steam will raise a cubic foot of water 18·18 feet high, besides overcoming the friction of the engine and the resistance of water to motion.
7. That one bushel (84 lbs) of coals, per hour, will supply an engine of 10 horse power, each horse power requiring 8·4 lbs. per hour.
8. That a bushel of Newcastle coals will produce ($10 \cdot 08 \times 1728 =$) 17,418 cubic feet of steam, and, consequently, raise ($17{,}418 \times 18 \cdot 18 =$) 316,666 cubic feet, or, ($316{,}666 \times 62 \cdot 5 =$) 19,791,625 lbs of water one foot high.

This was the performance of Watt's single power condensing engine 60 years ago, when he had not yet adopted the expansive principle, arising from which application, the improvements since

then, are astonishingly great, as the following table will show, taken from the Transactions of the Institution of Civil Engineers, Vol. II., page 67, being an extract from a Paper by Thomas Wicksteed "on the Effective Power of High Pressure Expansive Condensing Engines in use at some of the Cornish mines."

A Chronological Table exhibiting the gradual improvement of the Steam Engine in the course of 66 *years, the dates and quantities having been furnished by Mr. John Taylor, August 7th,* 1837.

Dates.	lbs. raised 1 Foot high with the Consumption of 1 Bushel or 94 lbs. of Coals.*	lbs. of Coals, ℔ Horse Power, ℔ Hour.
1769	5,590,000	33·33
1772	9,450,000	19·70
1786 to 1800	20,000,000	9·30
1813	28,000,000	6·64
1814	34,000,000	5·47
1815	50,000,000	3·72
1825	54,000,000	3·44
1827	62,000,000	3·00
1828	80,000,000	2·32
1834	90,000,000	2·06
1836	97,000,000	1·91

* Mr. Watt's Bushel of Coal is 84 lbs. or 10·64 ℔ Cent. less than the above. But the Bushel really is 88·548 lbs., *vide* p. 52.—*Author.*

In the month of June, 1839, I examined a pumping engine, belonging to the Carlisle Canal Company (then lately erected), made in Cornwall, and used to lift water from the river Eden, at Carlisle, for the supply of their canal.

DESCRIPTION.

The steam cylinder is 60 inches diameter—the stroke therein 10

feet—pump 45 inches diameter, and stroke therein 8 feet—lift 50 feet. The engine was going 7 strokes per minute, and was on duty 16 hours per day, and 6 days per week—the consumption of fuel (small coals) was three waggons of 50 cwt. in the ($16 \times 6 =$) 96 hours = 7½ tons, or 175lbs. per hour.

PERFORMANCE.

The water lifted 50 feet high, was 550½ imperial gallons each stroke, being at the rate of 231,210 gallons per hour, equal to 115, 605,000 pounds raised 1 foot high per hour, by means of 175lbs. of coal, or 660,600lbs. (66,060 gallons) raised 1 foot high with 1lb. of coals = 55,490,400lbs. lifted 1 foot with a bushel of coals weighing 84lbs., or, if calculated by the bushel of the above table of Mr. Taylor, viz., 94lbs. weight = 62,096,400lbs. lifted 1 foot by means of such bushel of coals.

This exhibits a very creditable result, though a good deal short of the best Cornish performances, being an advantage of full 3 to 1 over Mr. Watt's data of 1782.

Mr. Watt took out his patent for the expansive application of steam in the year 1782; but the progress of this invention was slow, and, notwithslanding the great advantages with which it was pregnant, as clearly and indisputably shown by him, many years elasped before they were practically elicited. Cornwall was the early seat of his success, and there a wide field lay open to him. The use of the steam engine, to clear the mines of water, was very extensive, coals were dear, and their comparative consumption, at that time, very great. Mr. Watt applied himself assiduously to the improvement of his engine, and he was very efficiently aided by the Cornish mine agents in carrying out his schemes. How prosperous those efforts were, time has shown; proving the almost never failing beneficial result of persevering talent and industry; but certainly, besides Mr.

Watt (to whose transcendent fame it is needless, if it would not be presumptious in me, to offer praise), mankind are greatly indebted to the Cornish engineers for the present perfection of that invaluable machine, the condensing, high pressure, expansive, steam engine. The improvements consist, first and mainly, of the expansive application of steam of high pressure—next, the better construction and setting of the boilers—the covering them well up—incasing the cylinders and steam-pipes with non-conducting heat materials to prevent condensation—the construction of the engine itself—and the high finish of its working parts.

From the year 1769—when the open topped cylinder and atmospheric pressure prevailed — to 1782 — when Watt's engine had reached a high degree of perfection—the benefit gained was nearly as four to one. In 1800, Mr. Watt's patent expired, after an extended term granted to him by parliament of from 14 to 25 years. Many establishments for making steam engines, on Mr. Watt's principle, were then commenced; but it would appear that the object principally aimed at was cheapness, rather than excellence, for they fell short, as to performance, of the Soho engines, and Boulton and Watt, for many years afterwards, kept up their price, and had increased orders.

The economy of fuel may almost be said to be scoffed at in this part of the world, and not without some degree of reason perhaps; for, in the first place, it is so cheap as to be scarcely an object of consideration; and next, being the staple trade, and the cause of great prosperity to the district, the general feeling is a desire rather to increase than diminish the consumption of coal. Unpopular as this part of the question may therefore be here, the saving in the wear of boilers is, nevertheless, worthy of regard; and for the benefit of the colliery engineers, I shall copy out from Mr. Watt's speci-

fication, an illustration of the saving derived from the expansive application of steam—viz.

"The elastic power of the steam of certain other sub-divisions of the length of the stroke, is expressed by the figures in the subjoined table, in decimal fractions of the whole original power.

"The sum of all these powers is greater than fifty-seven hundredth parts of the original power, multiplied by the length of the stroke; whereby it appears that when only one-fourth of the steam necessary to fill the cylinder, is employed, the effect produced, is more than one-half ($\frac{57}{100}$) of the effect which would have been produced in filling the whole cylinder full of steam, by admitting it to enter freely above the piston during the whole course of its descent. Consequently, the said new expansive engine is capable of easily raising columns of water, whose weights are equal to 5 ℔s. on every square inch of the area of its piston, by the expenditure of only one-fourth of the contents of the cylinder of steam at each stroke. And though, for example, I have mentioned the admission of one-fourth of the cylinders full of steam, as being the most convenient, yet any other proportion of the contents of the cylinder will produce similar effects; and in practice I actually do vary those proportions as the case requires."

Through the first 5 divisions the steam is in full force; being then shut off, the expansive principle begins.

Number of Divisions.	Length of Stroke.	The comparative Power of the Steam at each Division.
1	.. ..	1·
2	.. ..	1·
3	.. ..	1·
4	.. ..	1·
5	2 feet of the stroke	1·
6	.. ..	0·830
7	.. ..	0·714
8	.. ..	0·625
9	.. ..	0·555
10	4 feet or half the stroke ..	0·500
11	.. ..	0·454
12	.. ..	0·419
13	.. ..	0·385
14	.. ..	0·357
15	6 feet or three-fourths	0·333
16	.. ..	0·312
17	.. ..	0·294
18	.. ..	0·277
19	.. ..	0·262
20	8 feet or full stroke	0·250

Mr. Watt no doubt considered it unnecessary to show how he deduced his figures of the three lower compartments of the third column; but in order to make it clear to those who may not understand it, I shall show, by an example or two, how those decreasing sums are obtained. The steam is cut off at the end of the 5th division, or the first quarter of the stroke, when the expansive action commences. At the end of the 6th division the steam fills a space of one-sixth larger magnitude, and is, consequently, only six-fifths of the previous power, viz., $1.0 \times 5 \div 6 = 0.883$, which makes the table of Mr. Watt a trifle wrong. The next division—7th—is seventh-sixths of the last named, or, $0.883 \times 6 \div 7 = 714$, which agrees with the table. The next, or 8th division, is eight-sevenths of the last named, or $0.714 \times 7 \div 8 = 0.625$, which also corresponds with the table. By this process the table is easily followed out. It will also be seen how a corresponding operation of figures will apply to any shorter, or longer, curtailment of the steam in its passage into the cylinder. It is very readily seen also, how Mr. Watt comes at the $\frac{57}{100}$ of the original power, viz., the sum of the comparative power of the third column, consisting of 20 divisions, is 11.565, while the sum of the power of the same divisions, had the steam been allowed to flow freely into the cylinder to the very bottom, would of course be represented by 20. Therefore as 20.0 is 11.565, so is 100 to 57, his figure.

THE COAL OWNERS' COMPACT.

By way of conclusion to this miscellaneous production (the whole of which, however, has entire reference to the coal trade, and that more especially of the counties of Northumberland and Durham), I shall venture to make some remarks, and offer a few opinions, on the subject of the above heading, as the result of a thirty years' active connnexion with the coal trade, and a five-and-twenty years' service on its committees.

A pamphlet has been published, and limitedly circulated, under the title of "*Observations addressed to the Coal Owners of Northumberland and Durham, on the Coal Trade of those Counties,*" written by Mr. Thomas John Taylor; a gentleman well qualified for the task, by his individual attainments, as well as by his position and connexions. But why he should have been so chary of a work, certainly well calculated to correct the general misconception of the public mind, and to assist the coal owner in forming a right judgment with regard to his interests and best policy, I am quite at a loss to understand; for, sure I am, that any publicity given to the coal trade history of this district, is alone wanting to induce a right minded view of that heretofore misunderstood measure—the regulation—and Mr. Taylor would, in my opinion, have both promoted his own object, and conferred a favor on the public, by an extended distribution of his pamphlet. I never saw it until after I had formed the intention,

and in fact had commenced writing, this article; and it was not without some difficulty, and after repeated efforts, that I at last obtained the loan of a copy.

The author must have bestowed much time and labour in the collection of the facts and statistics, which are of great value; but I cannot help thinking, that his purpose would have been more effectively attained, by a less diffuse, and a more condensed arrangement of his materials. But most of all, I consider, he has failed, and that indeed signally, in not propounding a *project* for a new regulation. He shows, that in all time past, during a period of 180 years, the trade has been compelled to resort to regulations of vends—he explains, in some degree, how this necessity arose (though his reasoning on this head is not, perhaps, so ample and conclusive as it might have been)—and he tells the coal owners, very properly, that they have nothing to hope for, but in the adoption of that measure; and yet, notwithstanding all this, he stops short at the very point of the main object of his labours, and withholds his advice as to *how* it is to be accomplished and carried into execution; contenting himself with the general expression that "*whenever the disposition to an agreement again becomes unanimous, there will be found ample intelligence, and practical knowledge, amongst the coal owners, and their representatives, to constitute and administer an efficient regulation.*" This I cannot but look upon as a most unsatisfactory conclusion to a collection of very valuable information, and much able reasoning. Mr. Taylor could not help knowing that there never was, before, so miserable a failure of a coal trade compact—that, from its commencement to its termination, it fell very far short of effecting its purpose—that nearly its whole course was stigmatized by the most disgraceful violations of the agreement—and that it ended at last in a very extended feeling of disgust, and

thoroughly established opinion, that the trade could not come together again, but under a new system and a new government.

Mr. Matthias Dunn has published, what he calls, a review of Mr. Taylor's pamphlet; but it can hardly, I think, be properly so called, as very many of the topics are left untouched. He, however, notices the omission, complained of above, in a forcible manner, and speculates on the supposed disappointment of the coal owners, at not finding any specific plan laid down, by which they might see their way to a regulation, better calculated than the last, to meet the emergencies of the times. Mr. Dunn very properly goes on to remark that "*as Mr. Taylor is connected with some gentlemen highly influential in the government of the trade, and has not in his publication alleged that there is any better plan than the last; from this we must infer that there is none.*" This is no assumption, but an inference warranted by Mr. Taylor's concluding words, already quoted. Mr. Dunn, then, avails himself of the opportunity to present a scheme of his own for a new regulation, and which, probably, was the chief purpose of the review. The only novelties in his project, are—article 2, which proposes the appointment of a general manager, and article 5, the authorization of sales of bases, by one member to another. The former, I highly approve of, provided it be carried out far enough; but neither the manager's duties, nor qualifications, are sufficiently developed (of this I shall have to speak more at large, by and by, when I come to a project of my own); but the latter suggestion, I doubt the policy of altogether, and can only, as I at present view it, anticipate a fruitful source of mischief as likely to arise out of it, if it should be put in practice. I am at a loss to understand how a case might be supposed to occur which could justly claim from the trade the exercise of [illegible] privilege. If a colliery happened to be drowned out,

or otherwise to be laid in, the owner of it has no right to look for such a concession—if an owner has a larger basis than he can avail himself of, the excess ought to revert to the general body—or if a colliery ceases to be productive to its owner, or is worthless, surely, what may be left of its basis, is properly the trade's. Mr. Dunn, in his first article, proposes, in order, as he expresses it, "*to get the machinery into immediate working, to act on the late provisional basis, with arrangements for a speedy adjustment of the whole.*" Mr. Dunn cannot but be aware of the very great difficulty attendant on getting the basis sheet settled on all former occasions; and he must, I am sure, be sensible, that now, or whenever again another regulation is attempted, those difficulties will be very much increased; that the elapsed interval of time will have rendered many alterations in the bases necessary; and, also, that a material change in the constitution of the undertaking will be requisite, to induce a renewal of the union. He cannot, I apprehend, have given the subject the benefit of his usually penetrating reflection, or he would have seen how dangerous might be the consequence of so hasty a proceeding as that advised by him, viz., the over-eagerly clutching at a measure wholly unsettled, that would afterwards have to encounter infinitely greater difficulty of adjustment, or possibly hazard a rupture. I should be disposed to recommend an entirely different course—the avoidance of any hasty, crude, or half-arranged plan, as I would shun misunderstanding and strife. Before the "*machinery*" had motion given to it, it would be expedient and wise, in my opinion, not only to have the scheme fully understood, but to have the agreement perfected; by which I mean, that every signature should be attached, and the securities lodged: and I would have a principle recognised in the agreement, for the settlement of the basis sheet, without the individual interference of any one, in his own case. In short, I

would have a complete arrangement effected of the constitution and government of the regulation, before I suffered any motion to be given to the "*machinery*" of it, as the likeliest way of establishing a good, and a lasting understanding of the members of the coal trade.

The third article comprehends a matter of course arrangement—for a committee, clerks, &c., are indispensable; but the adjustment of the bases is another affair, and ought, as I have suggested, to be specially provided for, and upon which I shall have more to say.

The fourth article, which fixes the term of the agreement to be for not less than three years, is proper enough, so far; but it should be continuous, except under special circumstances—on this I shall have occasion to speak further when I come to a scheme of my own.

The sixth article proposes "ample securities" to be lodged with the manager. This, also, is a thing of course; but it is rather important that their nature and extent should be understood, which I shall further observe upon.

The seventh article suggests penalties to insure a strict observance of the rules—a matter of vital importance.

After thus freely commenting upon Mr. Dunn's project, I have to express a hope, that he will not think I have treated it too unceremoniously; but I must be candid and tell him, further, that the whole of his plan appears to me to be somewhat characterised by haste, and not to exhibit his accustomed skill and ability—that knowing, as I feel persuaded he could not fail to do, that a new principle—as to the general scheme—*must* mark the next regulation, I am not a little surprised that he was not prepared to offer something more generally original. I like his proposition of a "general manager," and his suggestion of frequently assembling the representatives; but not so often as fortnightly, for the great distances that many of them would have to travel, might cause it to

be seriously inconvenient; besides, it would be desirable to have those meetings well attended — monthly meetings might answer every purpose, and, to insure a good muster, might be enforced by a fine.

I shall now proceed to discuss, generally, the measure of regulation, and give my own views and opinions upon the subject.

The "Regulation"—"Restriction"—or "Limitation of Vends"—as this Northern Association has been variously denominated, has given rise to more hostile feeling on the part of the public, than the objects contemplated by it, or the measures adopted, really merited; for, while the coal owners were actuated by motives of a strictly protective nature, they were assailed on all hands (occasionally) with the charge of conspiracy, for the purpose of securing to themselves undue profits, by the exaction of unwarrantable prices, upon an article very commonly looked upon as one of the necessaries of life.* Had there been any truth in the charge, they would have merited the invectives and animadversions poured out upon them; but in verity there was not, neither was either cupidity or selfishness justly imputable to them. The said public were altogether wrong in their judgment, and neither rightly understood the matter, nor fairly appreciated the real purpose and tendency of a measure, the rather calculated to serve both the producer and consumer; in as much, as by the maintenance of a steady trade, removed alike from exuberance and depression, and preserving a medium of prices between the extremes of high and low, a healthful state of the markets might best be expected to be insured.

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* Among the many that have at different times, taken up this subject against the coal owners, none probably have done so more virulently, or foolishly, than a Lord Mayor of London, a few years ago. He, in his thirst for popularity (as was imagined), launched out charges and maledictions against them, the atrocity of which, was equalled only by their mendacity. The storm, nevertheless, passed away with his short-lived importance; and his inflated prognostications, and boastful threatenings, sunk into the grave of his mayoralty.

The coal trade of this district, is thus far a peculiar one, that its product—unlike the indurated and stone like hardness of the Staffordshire coal—is exceedingly friable, and chemically liable to rapid reduction by exposure to atmospheric influence; by which its value is materially lessened; and being both a bulky, heavy, and, comparatively, a low priced article, it cannot be stored up like more prizable merchandize; and must, therefore, be quitted, when once out of the mine, with but little delay, or a depreciation in its value necessarily follows.

Thus it is, that the coal-owner is naturally anxious to get off his property, for he cannot keep it on hand without a sacrifice; and furthermore, because he is *obliged* to carry on his workings. Hence arises that competition in sales, among a body of individuals, influenced by the same desires, which an open trade in coals, at these ports, has never failed to induce; aggravated, further, by a cause, arising out of the fact, that there exists in the trade a power to supply half as many more coals as are wanted. As Mr. Taylor very justly observes, it is proper that there should be an excess of the power of production over demand, because there are seasons of the year when, comparatively, few coals are called for; and again, others, when the call is beyond the average requirement; at which latter periods, were not a superabundant means possessed of meeting the public want, great inconvenience would be experienced, and prices considerably enhanced. As concerns the public then, it is fortunate that a surplus power is possessed; but as regards the trade, it operates most prejudicially—the excess of power, however, is far beyond any need.

A certain degree of forbearance on all hands, might, unquestionably, be made to remedy the evil of competition; but that the whole trade (nothing short of which would suffice) should spontaneously

act on this abstract principle of general good, is more than any one, at all acquainted with the nature of the business, could possibly look for.

In brief, the urgency prompted by large outlays; by expensive establishments; by heavy liabilities; by the necessity of selling; and the impossibility of lying by; present a series of causes that lead impulsively to the rivalry adverted to—a rivalry, most fatal to the well-being of the whole body of proprietors, and which nothing, as yet, has ever been able to modify or palliate, but a regulation. All experience irrefragably shows that an open trade in coals has always been adverse to a derivation of profit; and, it is to be hoped, sufficient reasons have been given to account for it. However the advocates of free trade may be opposed to an opinion of this nature, or to the admission of any exception to their general views, this is a case, notwithstanding, which cannot be brought within the pale of their dogmas. In times of suffering, the coal owner is not able, by any species of retirement, or cessation from his business, to save himself for the time, like every other trader, for reasons, which, in addition to what has been already said, there is no difficulty in further explaining. Here are large capitals irrecoverably sunk; heavy and onerous liabilities not to be cast off, incurred and to be borne; expensive establishments which must be kept up, to be supported; all which must go on for weal or woe. The merchant can forego his dealings—the ship owner can lay up his vessels—and it is competent to the manufacturer to close his works, during a disastrous period of trade; but the coal owner possesses no such power of temporary escapement from calamity—his mines and workings *must* be carried on although, perhaps, to a known loss, until better times come round.

I believe a very erroneous impression has existed in the public mind with regard to the general profits of the coal trade. A few

collieries—the comparative number of which has been small—have realised large gains; others, have paid very fairly; many very indifferently; and no insignificant number have been great losers. I am now of course speaking of what *has* been. Now, the case of the coal trade is a very different affair. At this time (July, 1847), after a period of some twenty-six months of open trade, ruin has come upon several concerns, and many others are doutbless in a tottering condition; while the first class collieries (those heretofore enviable and highly profitable undertakings) have experienced an extraordinary and, no doubt, a most inconvenient declension of gain, suffering under a still greater fall of prices than even the inferior coals. It has frequently been said, and is by many believed to be a fact, that if the whole profit and loss of the coal trade could be brought into one general amount, that a balance would be shown of less than 5 per cent on capital. However this may be, certain it is, that although we have heard a great deal said about the gains of those (heretofore) fortunate parties of the first class, but little notice was taken of the losers: probably it may have been owing, in some degree, to the success of the former, that many have been seduced into the trade, and fated to the latter.

From the state of collision in which the whole trade is now involved (although there is a considerable diversity of suffering) it might almost induce the monstrous supposition, that the general purpose was to try how bad it was possible to make it. But too true, however, it is, that a reckless desire to get off quantity, seems to predominate over every other feeling.

I am aware, that an opinion is held, if not even cherished—consonant with the old adage—*that the evil will effect its own cure*, by forcing the weaker parties out, and their collieries to be laid in. Certainly, nothing appears more likely than that this, to some

extent, may happen; but that any permanent benefit to the trade, would be likely to arise from such a cause, is a thing I altogether question; and the indulgence of any expectation of the kind is, in my opinion, as unwise, as it would probably be delusive. In the event of an occurrence of this description, and brighter prospects resulting (which might be the immediate consequence), they would, in all likelihood, be speedily followed by a resuscitation of those very collieries, under the hopeful circumstances of new capitalists with (possibly and not improbably) easier holdings; presenting new competitors, more formidable than their predecessors, who would require to be made to feel, before they could be taught, *that the trade will not go on profitably without a regulation.* Many—very many!—have had to learn this dear bought lesson, who turned a deaf ear to advice, until sad experience forced the knowedge upon them.

To remedy the consequences of an open trade, and to effect an arrangement of sales and prices, of a nature, calculated to yield a reasonable profit to the coal owner; has always, I believe, been the truly honest purpose of the coal trade agreements: and assuredly, as far as my experience goes, it empowers me to bear testimony to the further intention of the parties, to give an abundant supply to the markets, and only to check that ruinous redundancy which the want of an agreement has invariably occasioned.

A regulation, then, means a restriction of vends, so exercised, as to control them wholesomely, and obviate the passion for competition. Sometimes, and for a considerable period together, it has answered the purpose intended, very well; but at others, it has failed to do so. The latter result characterised the late regulation agreement during the whole period of its existence; but remarkably so, for many of the last years of its nominal being; proving how great a folly men of sense can sometimes be guilty of. Instead

allowing it to linger on in a worse than useless (in truth, in a pernicious and disgraceful) state of tolerance, it ought to have been put an end to half-a-dozen years before it was.

That the parties will eventually come together again, I can have no doubt, believing, as I assuredly do, that to do themselves any good (if not in many cases to avoid ruin) they must unite in a regulation. That a very large proportion of the trade should entertain strong feelings of repugnance against certain others of their body, and find much difficulty in bringing themselves to a reünion with individuals who so shamefully violated their late engagements, to the injury of those who honorably kept them, it is easy to imagine; but still it is to be hoped, that good sense will induce a right-minded disposition, and the dismissal of past recollections, for the sake of the future.

For the information of those who are not acquainted with the routine of the business, of a coal trade regulation, I shall enter into some elucidation of it; for I hold it to be desirable for the coal owners themselves that publicity should be given to their doings, because, as there is really nothing that requires concealment, or of which they have any occasion to be ashamed, the more fully their proceedings are known, the more are they likely to stand justified in the minds of every body. Mystery and concealment are apt at all times to gender suspicion; and as, here, there is no necessity for hiding what they do, from the whole world; but more especially from the heretofore precluded portion of their own body; the more open the whole of their transactions are rendered, and the less likely is distrust to show itself; but what is more important is, that those violations of engagements, or breaches of agreement, would, in such case, hardly be dared to be committed. Views, entirely differing from these have generally prevailed; and mischievously so, I am convinced; but I hope, in

time to come, a more liberal spirit will actuate the proceedings of the coal trade, and a better faith manifest itself among the members of it, in their mutual engagements.

The course of procedure has usually been, after the regulation deed had been executed, to agree upon a tariff of quantities (meaning an assumed annual sum of tons for each colliery, by which to adjust the periodical issues for the vends) and prices, made up and agreed to after, commonly, the expenditure of much time and labour. This, once settled, rendered the preparatory arrangements complete. The commmittee now gave out, to each colliery, the quantity allowed to be vended in the month (or fortnight, as the case might be) ensuing; the aggregate of which issues, was pretty well known, from experience, to be amply sufficient to satisfy the usual demand for the time. But in the event of its happening, from any extraordinary cause, that a larger quantity was likely to be wanted; no time was lost in giving out an additional issue. I never remember, however, that the markets were wanting in their needful stock of coals, owing to these proceedings of the coal owners. Adverse winds, or a temporary withdrawal of ships into other trades, might, and certainly did, occasionally, reduce their number, so as to produce an effect on prices; but the regulated vends, properly speaking, never, that I ever knew or heard of, caused any thing of the kind. If the fact be so, then am I entitled to assume, that the public have not had any ground of complaint against the coal owners, or their measures; for, so long as the markets are well served (and the fact is that they have always been superabundantly supplied, except from the causes just referred to, which were foreign to any acts of the coal owners), prices will be properly and fairly regulated by natural influences — indeed, this must, and will, be the result, whatever proceedings may b[illegible] on in the north.

What has been latterly said, will appear to have special reference to the London market; but the coast markets have not been worse circumstanced, for the "Turn Act" provides specially for good (indeed preferable) turns for the loading of ships not exceeding 6 keels, a class common to the by-ports. It is a singular truth, and well worthy of being noted, that on occasions of great advances of prices in London, and the coast markets (which not unfrequently has happened, from severe weather, or want of ships), the collieries in no one known instance ever raised their prices. This, if anything was necessary to prove the fact, at once establishes the reasonable views and fair intentions of the coal owners, and shows, that their regulation is nothing more than a protective measure.

I shall now assume, that time and circumstances have wrought such a salutary change in the minds of the coal owners, as to induce a belief that a general feeling is prevalent in favour of a renewed arrangement for a limitation of the vends; and that those individuals who have been accustomed to take an active part in the affairs of the trade, have made a movement in the business, and have reason to think that the general disposition has this tendency, and that, therefore, it is expedient to make the attempt to carry a regulation into execution. It is highly necessary, however, that this desire should exist, for I feel assured, unless it does, it will be in vain to endeavour to establish a strong and effective arrangement, anything short of which would only be productive of disappointment.

The scheme I am about to propose, I submit with all deference to those friends and individuals of the trade who, from their long experience, are entitled to be considered the best judges of the measure.

I have been guided by the conviction, that any future regulation, to be serviceable and lasting, must be founded on a new principle;

the leading feature of its constitution being, that as little as possible should be left to the discretional control of any members of the trade, for, if I am not very wrongly impressed, suspicion and jealousy have been mainly instrumental in causing the irregularities which have led to so much mischief; aided by a laxity of conduct on the part of the executive; than which, nothing could be more calculated to cause, by progressive degrees, all the evils that sprung up in the last unfortunate (miscalled) union.

I quite concur in Mr Dunn's suggestion of the appointment of a general manager, but I would carry out the office much further than he seems to have thought of doing. I would invest the individual with extensive powers, and thus render a committee merely auxiliary to him. Of course he ought to be a person in whom the trade could repose entire trust—possessed of a good knowledge of their affairs—of business habits—qualified to exercise a sound judgment—above all individual bias, and untrammelled by any trade connexion. Possessed of those attributes, and giving his whole attention to the affairs of the trade, he ought to conduct them beneficially. He should be liberally remunerated—have the appointment insured for some certain term—and be allowed to appoint his secretary. Perhaps a person endowed with these requisites, and having the confidence of the whole trade, may not be very readily met with; but if he can, I would make him the

CHAIRMAN AND GENERAL MANAGER,

Who should preside at all meetings—have a common and a casting vote—have the assistance of a secretary or clerk, with such subordinates as circumstances should render needful—be charged with all office business—act as treasurer, and be liable to such further duties, and possessed of such additio[illegible] comprised in the concluding article, headed. "

THE COLLIERY REPRESENTATIVES,

Consisting of an individual nominated on behalf of each colliery, with ample powers to represent the same, would probably be the first step taken, after an assured understanding that all parties were assenting to the proposed measure. At the first meeting of this body—which would be called so soon as the list was made complete—it might be convenient to appoint

A PROVISIONAL COMMITTEE

Of five representatives, to be charged to draw out an agreement under the general instructions of the meeting; and to recommend a person to be the general manager. The second meeting of representatives should receive the draft of agreement, discuss, and finally settle the same: determine, if possible, the appointment of a general manager; and choose the working

COMMITTEE,

Of 9 representatives (not more, as a large number is an evil)—5 to be a quorum—2 to go out at the end of every 3 months, by rotation; and the retiring members to be reëligible.

GENERAL MATTER.

The agreement ought to be comprehensive, but well condensed. It should be for a certain term of three years, at the least, and be binding on the parties and their assigns, &c.; be continuous, afterwards, from year to year, unless, and until, six months notice shall have been previously given in writing, and signed by not fewer than three representatives, expressive of their desire that it should be terminated at the end of the then regulation year; which year should date from the day of the first issue for vends. The agreement to contain the following provisions.

1. The representatives to hold monthly meetings, at the Coal Trade Office, in Newcastle, and be liable to a fine of five shillings each for every non-attendance—travelling expenses to be allowed to such of them whose residence shall exceed a distance of fifteen miles from Newcastle. To fill up the vacancies in the committee. To hold special meetings on the summons of the manager. To receive reports from the manager and committee, and decide thereon.

2. The committee to meet fortnightly at the Coal Trade Office, at such hour as the manager, from the amount of business to be brought before them, shall deem requisite—every alternate meeting being on the day previous to the monthly meeting of the representatives—each member to be subject to a fine of five shillings for non-attendance, or for arriving more than a quarter after the hour fixed—to receive half-a-guinea each for every attendance, and such individuals as live more than 15 miles from Newcastle, to be paid their travelling expenses. To hold special meetings whenever summoned for that purpose by the manager. At the first meeting in every month the issues for the month to be determined, in the following manner:—The manager to receive from each individual of the committee present, his opinion of the quantity proper to be given out, and "*shall then be entitled to decide, and draw the line which he may judge best adapted to the general interests of the trade.*" This suggestion is also borrowed from Mr. Dunn, and is, I think, a very proper one. Should the quantity, so fixed upon, be deemed by the manager, in the course of the month, to be less than the markets appear likely to require ... hen, in his discretion, issue to the trade ... ty. If the

expediency of such a proceeding shall be apparent about the time of the intermediate meeting of the committee, he shall take their opinion upon it in like manner as at their previous meeting. The books and other accounts to be submitted by the manager at each meeting—liability to fines for irregularities to be submitted also, and decided upon. To make a report every month to the representatives of all matters and things which it may be desirable for them to know, saving only the needless occupation of their time by any unnecessary communications—all and every breach of the rules to be specially noticed.

3. The manager, or his secretary, to be allowed to examine such Fitting Office Books as shall show the vends and prices, in order to clear up any dispute or question that may have arisen in respect thereof.

4. Fitters to attend the committee or representatives when called upon for the purpose by the manager.

5. Fines to be imposed on representatives for not duly making returns to the manager, or for making untrue ones.

   For exceeding the allowed issue beyond the completion of a ship's loading, which excess shall be deducted from the succeeding month's vend.

   For not paying quarterly contributions when applied for.

   For a non-adherence to price, unless under the written permission of the committee or the manager.

   A heavy fine to be inflicted for a determined breach of the agreement.

   For any excess of weight either by the waggon or in a ship's cargo.

6. All fines to be paid on demand of the manager, or his secretary.

7. Security to be given by each representative, or by an owner of the colliery; of the amount of one-twelfth of his basis, multiplied by the highest price of his coals; as a guarantee, not only for the due payment of his fines, but for the fulfilment of his obligation generally to the trade; which amount shall be forfeited to the general fund in case of an abandonment of the agreement. The nature of the security to be such as can, without doubt or question, be enforced—a bond, or bond in judgment. Such obligation not to be used but under the order of a general meeting. The manager to receive the securities, and after sealing them up in the presence of the representatives, with his own seal and those of two representatives, he shall lodge them for safe custody with the Bankers; and the packet may not be opened but at a meeting of representatives.
8. The general bases sheet should be so constructed, as to represent, as nearly as may be, the actual coastwise vend from the Rivers Tyne, Wear, Tees, and Blyth, and the ports of Hartlepool, Seaham, Hartley, and Warkworth, on an annual average export of the last three years. A return to be made, by each representative, of the coals vended coastwise by his colliery in each of the last three years, ending on the 31st of December preceding, such returns being checked by the Customs accounts. A sheet to be printed, with the average annual coastwise vend of all the collieries, and sent to each representative, who shall return the same, filled up against each colliery, with the amount of vend he may consider fair and reasonable as its year's vend, making the sum total of his views to correspond with the real annual average of the trade, as shown by the printed amount sent him. A general

average of these latter returns to be made, and upon them the manager to be entitled to exercise the following discretionary power, viz., to increase any one or more of such quantities by a sum not exceeding 12½ per cent.; or to reduce any one or more of them by a sum not exceeding 7½ per cent. The sheet thus made up, whether in the aggregate sum, it exceeds, or is less than, the actual average yearly vend coastwise, of all the collieries, to be deemed the final settlement of the general bases sheet, and to be binding on the whole trade for one year; at the expiration whereof—or at the end of any subsequent year (the year beginning and ending with the date of the first month's issues)—any one or more of the representatives to be at liberty to call for a revision of his, or their quantity, or quantities; making application to the manager, in writing, not less than three calendar months previously; which application, or applications, to be reported upon by the manager and committee, with their opinion to the representatives on the case or cases, one month, at least, prior to the end of such year; and the representatives to decide on the application or applications at their next following monthly meeting, which shall be binding on the party or parties

9. Loadings of keels and spout waggons, to be inspected from time to time, and any excess of weight to be reported to the manager.

10. Contributions, by a per centage on each basis, to be fixed by the representatives, quarterly, and forthwith collected.

CONCLUDING REMARKS.

There may, and most likely would, be other matter to add to the agreement, but all the material points, I think, are noticed.

The provisions are very stringent, which could not be objected to by parties intending to act honorably (but the contrary), because such would be their best security for a faithful observance of the regulation by all parties.

The mode laid down for settling the bases sheet, has been the result of much reflection, and I trust will not be too hastily condemned. I am of opinion that no satisfactory course of determining the annual quantities, can be pursued, if the whole is to be adjusted by treaty; and I consider it to be importantly necessary, that a principle should be acted upon by which the question shall be entirely removed from the control of interested individuals.

The securities given for the maintenance of good faith, and an honorable adherence to engagements,—a breach of which might very injuriously affect a large community—ought to be such as might be enforced, if possible, without the necessity of having recourse to a legal tribunal; and the amount, in order to effect this, should not be less than a twelfth part (one month's average vend) of the basis, in order to impose a due restraint on the trade.

I think it will be apparent that the leading purposes of this scheme are, first the establishment of an agreement that will not be likely to be broken through, or infringed; and next, that a principal is proposed for determining the basis, which will take the business, in a great measure, out of the hands of individual coal owners.

that reserve and secresy are discarded, and a popular feeling and influence shared among the whole body.

There are many important topics connected with the subject of a regulation of vends, which I have not deemed it necessary to speak upon, because they have been already discussed by Mr. Dunn in his "Historical Account," and by Mr. Taylor in his "Observations."

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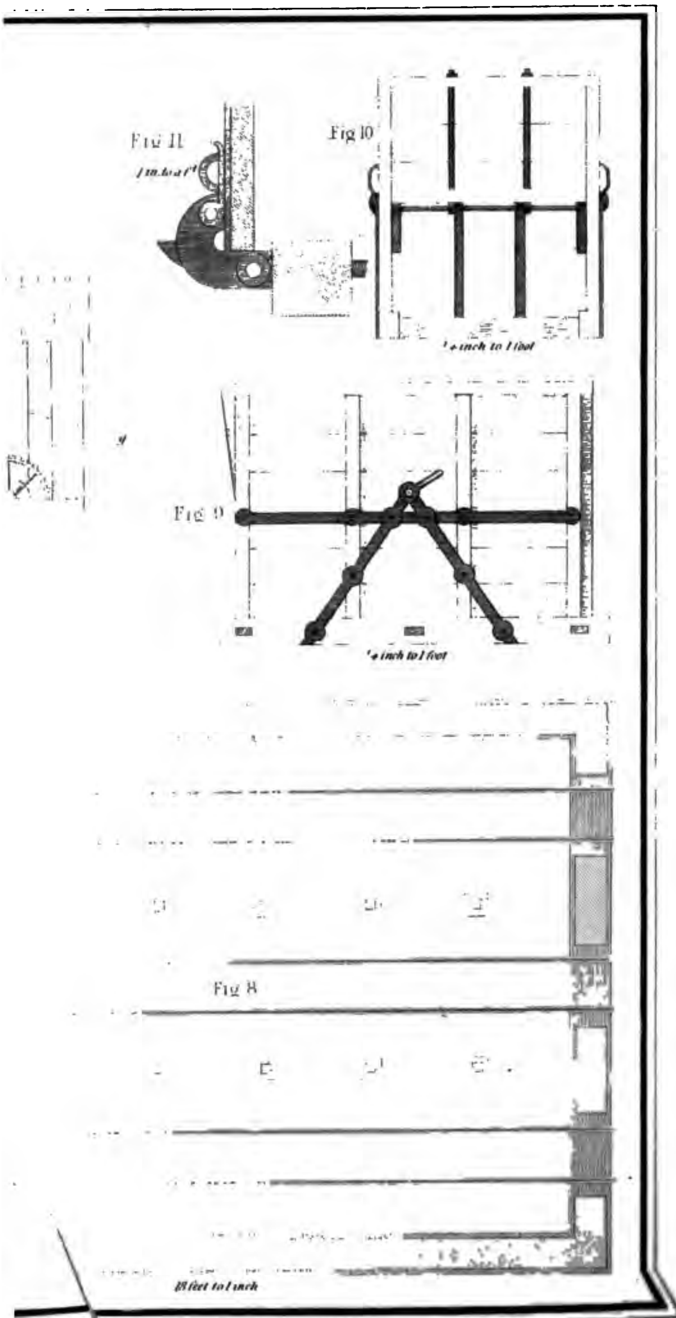

Fig 11
Fig 10
inch to 1 foot
Fig 9
inch to 1 foot
Fig 8
feet to 1 inch